INSTRUCTION MANUAL

OSCILLOSCOPE CAMERA SYSTEM

C-40 Camera And Accessories

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

Serial Number 10443

OSCILLOSCOPE CAMERA SYSTEM

C-40 Camera And Accessories

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WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

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Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

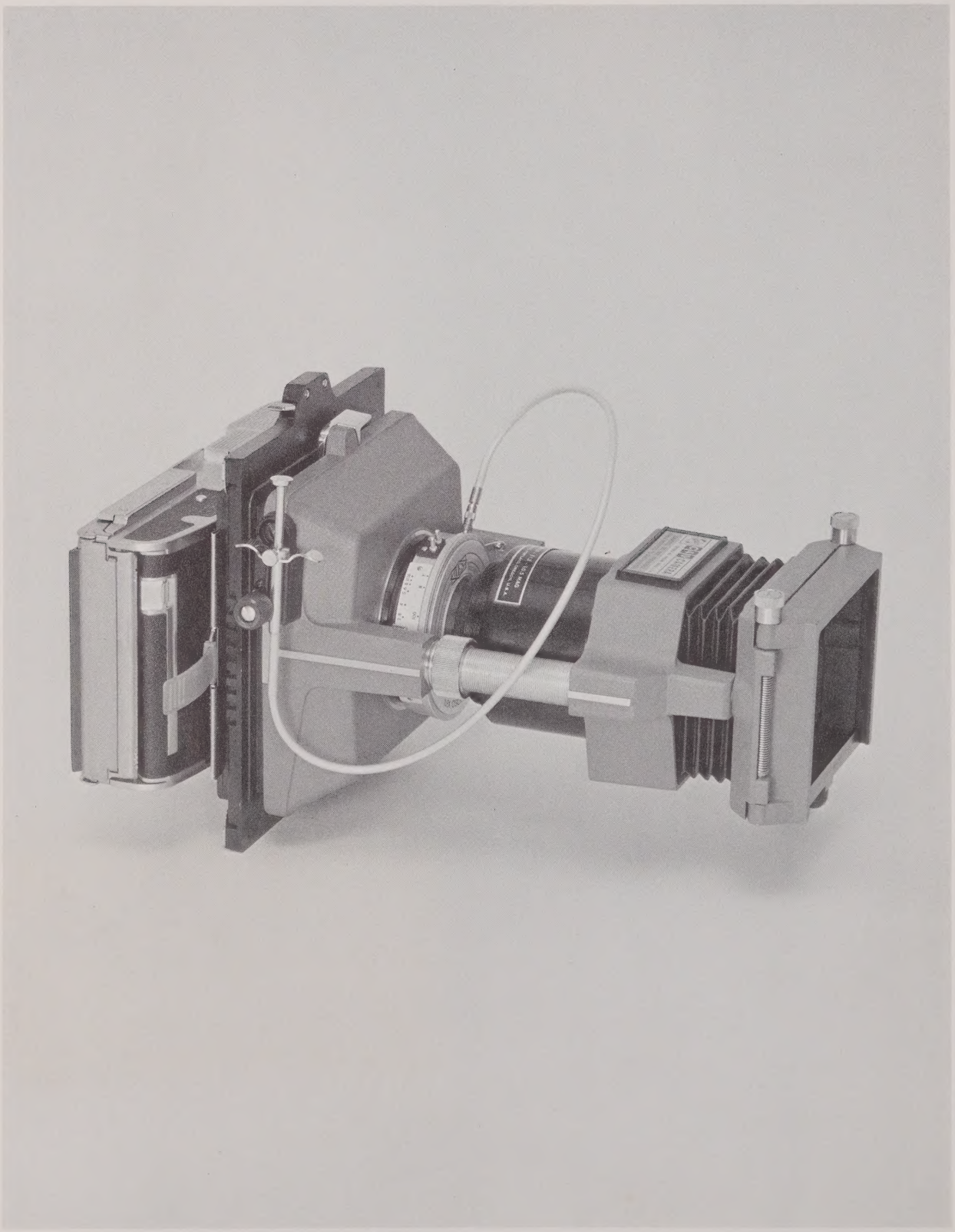


Fig. 1-1. Tektronix Type C-40 standard camera.

SECTION 1

CHARACTERISTICS

General Description

The Tektronix Type C-40 Camera has been designed to take advantage of Polaroid[1] Land Polascope film (this film has an equivalent ASA rating of 10,000) and the best lens Tektronix, Inc. has available for its oscilloscope camera systems. The Type C-40 Camera is designed to mount on Tektronix, Inc. 400-series Oscilloscopes having somewhat higher writing rates than can be accommodated by the Type C-30 Camera.

NOTE

The Type C-40 Main Frame can be purchased as a separate item. This alows the lens, rear frame, rotating slide and camera back off another camera such as the C-12, C-27, etc., to be used in making up the complete camera system.

To acheive the optimum writing rate capabilities of the Type C-40 Camera System, a lens having a maximum aperture of f/1.3 and an object-to-image ratio of 1:0.5 should be used.

The optical system of the camera permits photographs to be made directly from the oscilloscope screen so the image is not reversed.

The camera provides many new convenience features. Slide on type mounting is used so that the camera can easily be mounted or removed. Swing-away hinges allow it to be swung out of the way either to the left or right so the CRT display can be conveniently viewed.

CAUTION

The Tektronix Type C-40 Camera should not be subjected to a shock in excess of 15 G for as much as 11 milliseconds.

The rotating slide adapter allows any of the parfocal film-holding backs used with it to be locked in any of nine detented positions. All camera backs can also be rotated in 90-degree increments so that the long axis of the film will be parallel or perpendicular to the trace as desired.

Several lenses in addition to the standard lens may be used with the camera. The wide range of object-to-image ratios and maximum apertures permits you to select the lens which is just right for your application.

Parfocal backs which may be used with the camera allow you to make photographs on Polaroid Land or conventional film, in either sheet or roll film forms.

[1]**Registered trademark of the Polaroid Corporation.**

MAIN FRAME

Focusing

Focusing to compensate for slight differences between oscilloscopes is accomplished by means of two set screws (one on each side of Main Frame). The set screws are loosened, then the Main Frame is slid forward or backward until the ground glass image is in focus. Once the camera is in focus, it is locked in position by tightening the two set screws.

Mounting

Tektronix 400-series Oscilloscopes do not require an additional bezel for mounting the camera. The Type C-40 Main Frame is attached or removed from the oscilloscope by sliding the camera into or out of the groove on the oscilloscope bezel.

Optical System

Photographs taken directly from oscilloscope screen with no reversal.

Viewing

The camera may be swung from the CRT either to the left or right on its swing-away hinge to provide display viewing.

Size (Main Frame Only)

Approximately 4-1/2 inches high, 8 inches deep and 6-1/4 inches wide. (Measurements taken without an additional bezel.)

Weight (Main Frame Only)

2 lbs, 2 oz.

Size (Type C-40 Standard Camera)

Approximately 6-3/4 inches high, 14 inches deep and 9-3/4 inches wide. (Measurements taken without any additional bezel.)

Weight (Type C-40 Standard Camera)

9 lbs, 9 oz.

TABLE 1-1

Lens Stock No.	Type	Max. Aperture	Object-to-Image Ratio	Shutter
122-0547-00	Oscillo-Raptar	f/1.9	1:0.7	Alphax No. 3 or Ilex (Elgeet) No. 3X Universal
122-0550-00	Oscillo-Amaton	f/4.5	1:0.7	Alphax No. 1
122-0549-00	Oscillo-Raptar	f/1.9	1:0.5	Alphax No. 3 or Ilex (Elgeet) No. 3X Universal
122-0608-00	Oscillo-Raptar	f/1.4	1:1	Alphax No. 3
122-0548-00	Oscillo-Navitar	f/1.9	1:0.9	Alphax No. 3 or Ilex (Elgeet) No. 3X Universal
[2]122-0662-00	Oscillo-Navitar	f/1.3	1:0.5	Ilex No. 3X
122-0692-00	Oscillo-Navitar	f/1.9	1:0.85	Alphax No. 3 or Ilex (Elgeet) No. 3X Universal

[2]Standard lens for Type C-40.

LENSES (see Table 1-1)

Lens and Shutter Settings

Both lens and shutter settings can be made from the side of the camera without removing or unlatching the camera from the oscilloscope.

Shutter Speeds

Alphax No. 1 Shutter—(T), (B), 1/10, 1/25, 1/50, 1/100, and 1/200. X Synchronization.

Alphax No. 3 Shutter—(T), (B), 1, 1/2, 1/5, 1/10, 1/25, 1/50 and 1/100. X Sychronization.

Ilex (Elgeet) No. 3X Universal Shutter—(T), (B), 1, 1/2, 1/5, 1/10, 1/25, 1/50 and 1/100. X Synchronization.

REAR FRAMES AND ROTATING SLIDE ADAPTER

Standard (122-0591-00)

The Rear Frame is used with the rotating slide adapter (122-0602-00) to allow the camera backs to be mounted. This combination allows any of the standard camera backs to be rotated in 90-degree steps. The long axis of the film can be either parallel or perpendicular to the trace.

The nine indentations of the standard camera backs permit the camera back to slide to any of nine positions. The position of the camera back is indicated by the number on the rotating slide adapter.

Power Supply Frame (016-0231-00)

The Power Supply Frame replaces the standard Rear Frame and contains the power supply circuitry for the Model 3 Shutter Actuator. It is used with the rotating slide adapter (122-0602-00) to allow the camera backs to be mounted. This combination allows any of the standard camera backs to be rotated in 90-degree steps. The long axis of the film can be either parallel or perpendicular to the trace.

The nine indentations on the standard camera backs permit the camera back to slide to any of nine positions. The position of the camera back is indicated by the number on the rotating slide adapter.

CAMERA BACK

Polaroid Land Roll Film Camera Back (122-0603-00)

Prints or transparencies in black and white or color may be obtained from a roll of film. Picture size in most cases is 3 1/4 × 4 1/4. [3]Only Polaroid Land roll film can be used with this back.

Polaroid Land Pack Film Camera Back (122-0671-00)

Black and white or color film is available for the pack film back. Picture size is 3 1/4 × 4 1/4. [4]100-Series Polaroid Land film packs should be used with this camera back.

Graflok (122-0604-00)

Any type of film holder which will attach to the Graflok back can be used. The various attachments available will allow sheet or roll film of conventional or Polaroid Land types to be used. Maximum image size available is 4 × 5 inches.

Graflok (016-0233-00)

Any type of film holder which will attach to the Graflok back can be used. The various attachments available will allow sheet or roll film of conventional or Polaroid Land types to be used. Maximum image size available is 2 1/4 × 3 1/4 inches.

Shutter Actuator Model 3 (Holding Type)

The Shutter Actuator System Model 3 is a rotary solenoid-operated shutter release control. The Shutter Actuator has been designed to be used with the Tektronix Camera Systems.

The Shutter Actuator System permits electrical triggering of the camera shutter. It can also be used to trip more than

[3]This back will accept Polaroid Land film having an equivalent ASA rating of either 3,000 or 10,000.

[4]This back will accept Polaroid Land film having an equivalent ASA rating of 3,000. It will not accept Polaroid Land film having an equivalent ASA rating of 10,000.

one camera shutter simultaneously, through the use of more than one Shutter Actuator System tied to the same remote switching control.

The power supply is available in two different types of housing, a Rear Frame housing and a separate small box style. The Rear Frame housing is intended to mount in place of the normal Rear Frame of the Tektronix Camera System. Since the Rear Frame type power supply is not easily moved from one camera to another, a box style power supply is available which can be easily attached to the camera back, by using the power-supply mounting bracket (Tektronix Part No. 122-0713-00), or the power may be set on an object near the camera.

The same Shutter Actuator solenoid is used with either style power supply.

Power Requirements

Power Supply

Line Voltage—115 (230) volts, 50 to 400 hertz, or 115 (230) VDC.

Fuse—½ A (0.3 A) slow-blowing type.

Shutter Actuator

Input Voltage—115 (230) VDC

Peak Current—1 (½) A

Holding Current—0.13 (0.067) A

System Delay

The length of time required for the shutter to become fully open after the MOMENTARY-OFF MAINTAIN switch has been operated is approximately 20 to 25 milliseconds, depending upon the type of shutter used.

MECHANICAL CHARACTERISTICS

Power Supply

Power Supply Frame

Finish—Die Cast Rear Frame is finished in textured blue vinyl paint. The two control panels are anodized aluminum.

Dimensions—6 3/8 inches long × 8 1/2 inches wide × 3 5/16 inches deep.

Power Supply Model 3

Finish—Aluminum box is finished in textured black vinyl paint. The front panel is anodized aluminum.

Dimensions—4 1/16 inches long × 3 1/16 inches wide × 3 1/8 inches deep.

Shutter Actuator Solenoid

Finish—Die-cast case is finished in black. The name plate is anodized aluminum.

Dimensions—2 1/2 inches long × 2 1/16 inches wide × 1 3/4 inches deep.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

MAIN FRAME

Mounting the Camera

Before mounting the camera on a Tektronix 400-series Oscilloscope, the light seal in the support casting should be checked to insure it is the proper one. If it is not the correct one, remove the foot from the support casting (see Fig. 2-1) by unscrewing it. Insert the proper light seal, then re-install the foot to hold the light seal in place. For most photographic work, it is recommended that any mesh or light filters also be removed from the oscilloscope.

The camera can now be mounted to the oscilloscope by sliding the camera into the groove on the oscilloscope bezel. The camera can be removed at any time by lifting it off the oscilloscope bezel. The hinge system of the support casting permits the camera to be swung open either to the left or right by lifting the opposite hinge pin (see Fig. 2-1) and swinging the camera away from the support casting; or the support casting may be detached from the camera completely by lifting both hinge pins simultaneously.

Slide-on mounting has been incorporated to provide a fast and easy method of camera mounting or removal, particularly when one camera is used with several oscilloscopes. If, however, a more secure attachment is required between the bezel and the oscilloscope it can be obtained by tightening the two set screws (mounting lock adjustments) located in the support casting with a $5/64$ hexagonal wrench.

To obtain access to the two set screws (mounting lock adjustments) it is necessary to swing the camera away from the support casting. The camera may be swung away in either direction or removed completely, whichever is most convenient. The two set screws are located in the half-round boss on each side of the support casting next to the light seal groove.

The two set screws need only be turned slightly clockwise to effectively lock the support casting onto the bezel. To remove the support casting from the bezel, it is necessary to loosen both set screws by turning them counterclockwise until the support casting slides the bezel easily.

LENSES

Adjusting the Lens Aperture

The APERTURE selector (see Fig. 2-1) is used to select the lens opening. The dial is calibrated in f-stop numbers with a small pointer to indicate the settings.

The lens setting to be used for a particular picture depends on several factors. Whenever possible, use of f-stop numbers lower than f/4 should be avoided. As in all cameras, the best depth of field is obtained at the smallest openings (largest f-stop numbers). This is important in all oscilloscope cameras, because the trace and an external graticule cannot simultaneously be brought into focus when the f-stop number is lower than f/4. In applications where it is necessary to use the lens wide open, special techniques can be used to obtain a satisfactory picture with both the trace and graticule in focus. These techniques are described in Section 4 of this manual.

Additional information on selecting lens openings for particular applications is given in the Photographic Techniques section of this manual.

Selecting the Shutter Speed

The camera shutter speed is selected by means of the SHUTTER SPEED selector (see Fig. 2-1). Numbers shown on the SHUTTER SPEED selector are actually the reciprocals of the shutter speeds. For example, when the SHUTTER SPEED selector is set at 25, the shutter is open 1/25 second. As with the aperture setting, many factors determine the shutter speed used for a particular picture. Care must be taken that the right combination of lens opening and shutter speed is chosen so that the desired results may be obtained. More information on selecting the shutter speed is contained in the Photographic Techniques section of this manual.

Releasing the Shutter

The SHUTTER RELEASE control is located on the left side of the lens assembly. When the SHUTTER RELEASE control is raised, the shutter mechanism is actuated. In all positions of the SHUTTER SPEED selector except (T) and (B), the shutter mechanism operates independently of the time the SHUTTER RELEASE control is held up. In the (B) position of the SHUTTER SPEED selector, the shutter remains open as long as the SHUTTER RELEASE control is held up. When the control is released, the shutter closes. In the (T) position of the SHUTTER SPEED selector, the shutter is opened the first time the control is raised. It is then necessary to raise the SHUTTER RELEASE control a second time in order to close the shutter.

CAUTION

Do not attempt to force the SHUTTER RELEASE control. When the SHUTTER SPEED selector is set at (T), the release control will not return to the closed position the first time the control is actuated. Attempting to force the control to the closed position will damage the shutter mechanism. Raise the control a second time to close the shutter.

Changing Lenses

Several lenses can be used with the camera. All except the Elgeet type can be changed by following the procedure outlined below: (see Fig. 2-2).

1. Install the dark slide in the camera back.

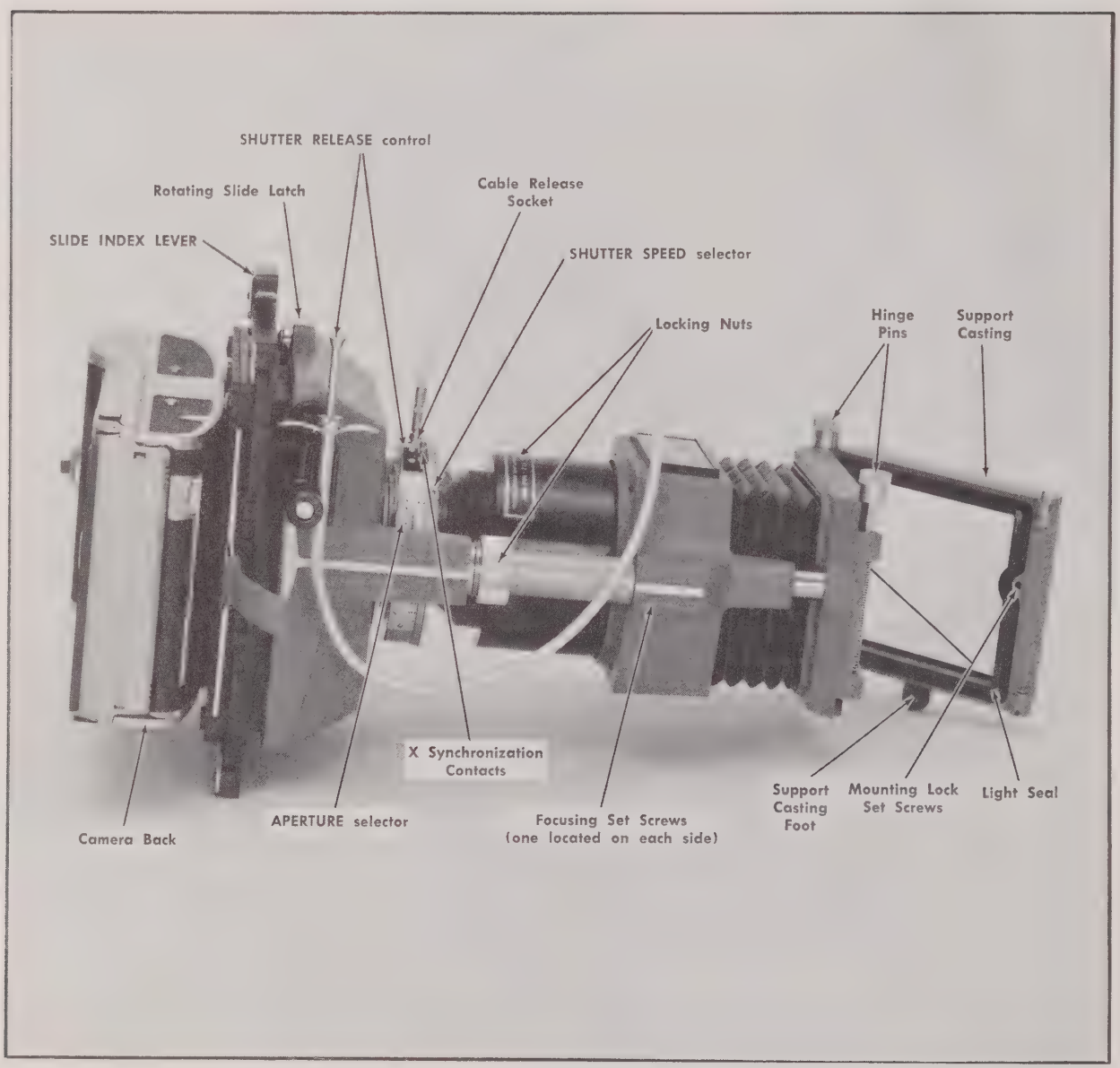


Fig. 2-1. Camera system operating controls and their functions.

2. Simultaneously unscrew the locking nuts holding together the front and rear portions of the camera frame.

3. Remove the rear portion of the camera frame and unscrew the lens assembly.

4. After checking the new lens for cleanliness, screw it into place on the frame and reverse the above procedure to complete re-assembly.

5. Adjust the locking nuts so the front of the lens seats against the rear of the camera frame. Do not excessively tighten the locking nuts, as it may impair shutter operation. After changing lenses, minor re-focusing of the camera may be necessary.

Special Information for Elgeet Lenses

Fig. 2-3 shows details of installation of an Elgeet lens. In changing Elgeet lenses, after installing the dark slide in the camera back, the rotating slide adapter must be removed. This is done by lifting the rotating slide lever and lifting out the slide adapter assembly.

After removing the rear of the camera frame as previously explained, reach in through the back of the rear frame and unscrew the metal locking ring which holds the Elgeet lens in place. Once the locking ring has been removed, the lens assembly can be lifted out from the back.

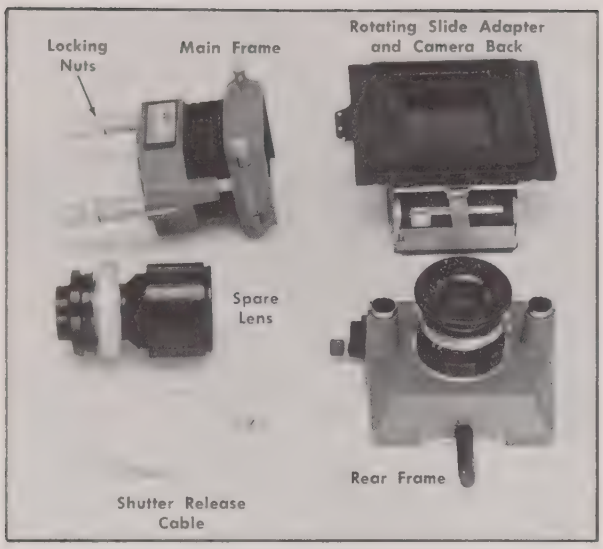


Fig. 2-2. Components described in changing the lens.

To install the new lens assembly, the above procedure should be reversed. The metal locking ring should be screwed hand tight after the lens assembly is seated in place.

Again, minor re-focusing may be necessary after installation of the Elgeet lens.

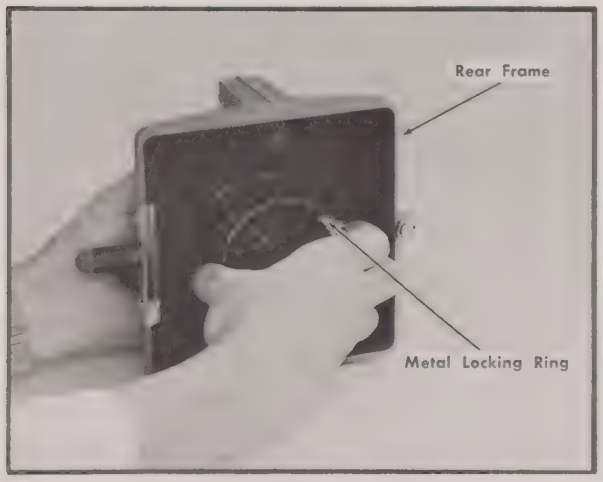


Fig. 2-3. Removing the metal locking ring from an Elgeet Lens.

REAR FRAME

Standard and Power Supply Frame

Mounting

Install the desired lens into the rear frame. Screw the locking nuts, see Fig. 2-1, toward the main frame until the rear frame will slide onto the supports far enough for the lens to be snug against the main frame. Tighten the two locking nuts onto the rear frame simultaneously until they are finger tight. If the locking nuts are tighten excessively, pressure on the shutter assembly may make the shutter inoperative. After tightening the two locking nuts, the camera should be focused.

ROTATING SLIDE ADAPTER

Mounting the Camera Backs

Lift up the rotating slide latch and slide the ledge on the bottom of the rotating slide adapter into the slot on the rear frame. Press the top of the rotating slide adapter up against the rear frame and press down on the rotating slide latch to lock the rotating slide adapter into place. The rotating slide adapter can be placed on the rear frame to permit either vertical or horizontal sliding of the camera backs.

Non-Adjustable Rotating Slide Adapter

When the rotating slide adapter is in place, press down on the slide index lever (see Fig. 2-5). While holding down the slide index lever, insert the desired camera back onto the tracks of the rotating slide adapter. Be sure to hold onto the camera back until the slide index lever has been released and the camera back has firmly locked in place.

The camera back may be set in any one of nine positions by pressing the slide index lever and moving the camera back to the desired position. The various stops of the camera back have been numbered; this number will appear in a small hole on the slide adapter assembly.

It is a good idea to leave the dark slide in the camera back until the back has been properly seated on the camera. The dark slide should also be used whenever the camera back is changed, if either back contains film.

Adjustable Style Rotating Slide Adapter

When the rotating slide adapter is in place, press down on the slide index lever. While holding down the slide index lever, insert the desired camera back onto the tracks of the rotating slide adapter. Be sure to hold onto the camera back until the slide index lever has been released and the camera back has been firmly locked in place.

The camera back may be positioned in any one of nine positions by pressing the slide index lever and moving the camera back to the desired positions. The various stops of the camera back have been numbered—this number will appear in a small hole of the slide adapter assembly.

It is a good idea to leave the dark slide in the camera back until the back has been properly seated on the camera. The dark slide should also be used whenver the camera back is changed if either back contains film.

The adjustable rotating slide adapter has been constructed so that it can correct for discrepancies in vertical and horizontal film tracking in the camera back, and/or slight camera system misalignment. If the image is always off center on the film frame in the same direction, one, or both of the above difficulties is probably the cause.

The following procedure should be used as a guide when making film framing corrections with the rotating slide adapter.

a. Note the amount and direction of image movement which will be required to center the image on the film frame.

NOTE

The amount of correction required to center the image on the film frame is one-half the distance from the present image position to the new image position.

The direction the rotating slide adapter must be moved with respect to the rear frame to center the image in the same direction the image must be moved on print, as normally viewed, to become centered.

b. Remove the camera back from the rotating slide adapter. It is not necessary to remove the rotating slide adapter from the remainder of the camera system.

c. Note the relationship of both the vertical and horizontal white index lines to the index marks of the rotating slide adapter, see Fig. 2-4.

d. Loosen, but do not remove the four countersunk screws, see Fig. 2-4. Move the back portion of the rotating slide adapter to the desired marks of the rotating slide adapter as alignment guides.

e. When the rotating slide adapter has been correctly positioned, re-tighten the four countersunk screws; see Fig. 2-4.

NOTE

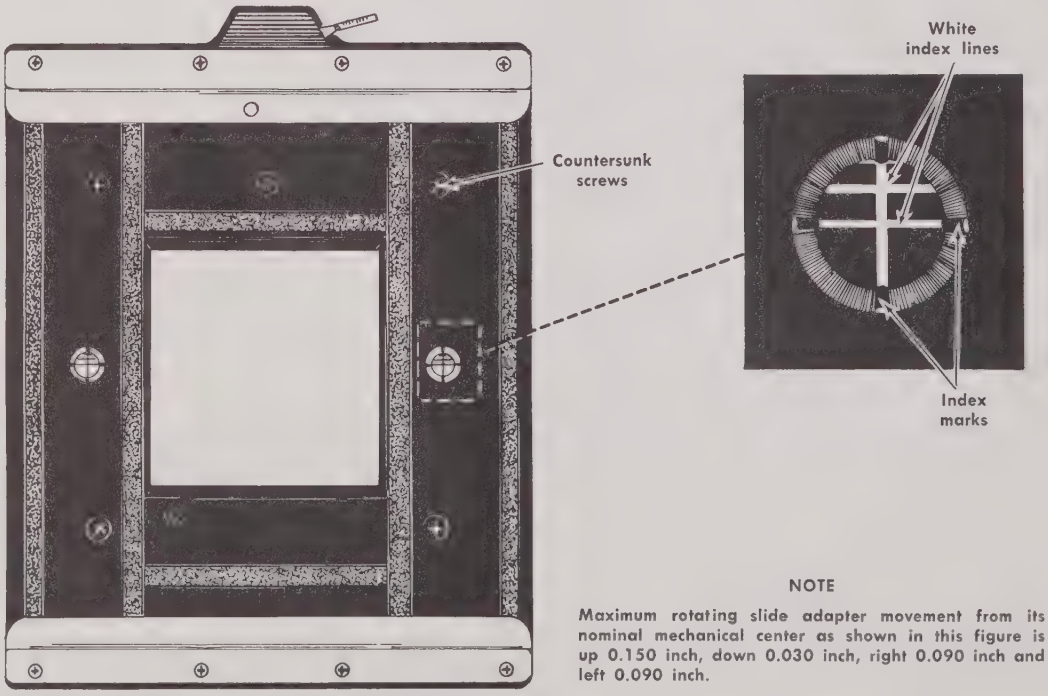
Seldom will the adjustment of the rotating slide adapter remain ideal when the camera is switched from oscilloscope to oscilloscope or after various camera components are interchanged.

CAMERA BACK

Selecting the Camera Back

The choice of a camera back will depend primarly on the intended use for the photograph; how quickly you want the finished photograph, how large an area you wish to photograph, the magnification factor of the particular lens used, and the size of the negative desired. If you want to obtain a negative from which a number of prints can be made, either Type 55 P/N film (which comes in Polaroid Land 4 × 5 only) or conventional film is quite satisfactory. Both the Polaroid Land 4 × 5 film holder and the holders for conventional cut and roll film are used with the Graflok back in place.

With either Polaroid Land or conventional films, the size of the film used by the selected back must be at least as large as the image from the lens. This will depend on the



NOTE

Maximum rotating slide adapter movement from its nominal mechanical center as shown in this figure is up 0.150 inch, down 0.030 inch, right 0.090 inch and left 0.090 inch.

Fig. 2-4. Adjustable Style Rotating Slide Adapter.

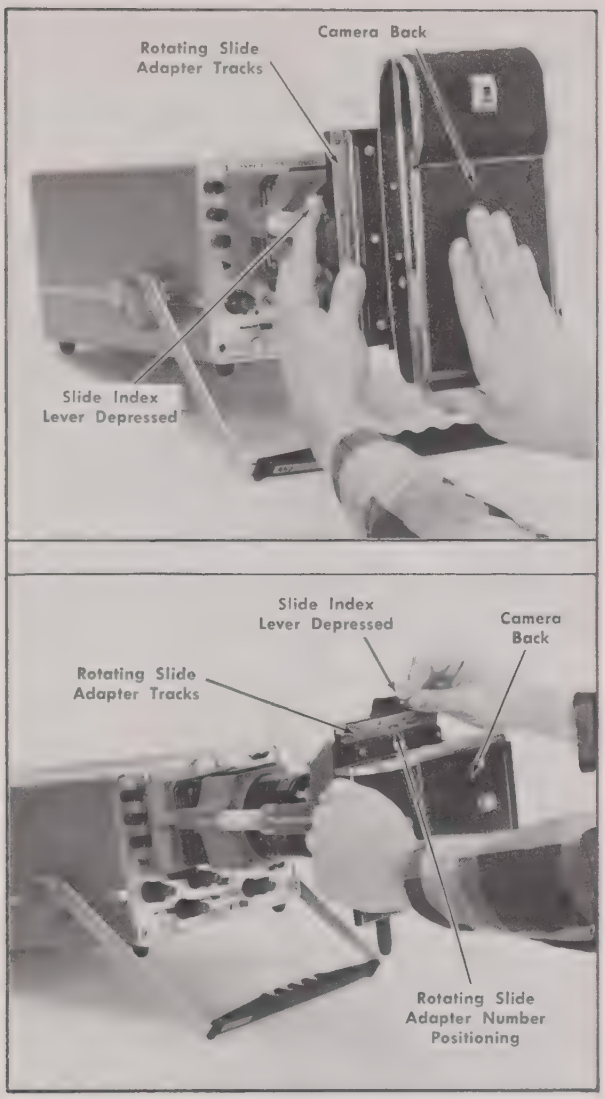


Fig. 2-5. (A) Shows the rotating slide adapter installed to permit vertical sliding of the camera back. (B) Shows the rotating slide adapter positioned for horizontal sliding.

object-to-image ratio of the camera lens and on the size of the oscilloscope display. For example, the roll film back for 120 or 620 film would probably not be used with a 1:0.9 lens and a 10-cm wide oscilloscope display. This is because the image of the display is 9 centimeters wide and the long dimension of the film is only about 8.25 centimeters. Thus, at least 7.5 mm would be cut off the photograph.

In actual practice, the film size should be at least 5 mm larger than the size of the image to allow for normal tolerances in the construction of the camera backs and for the position of the film in the back.

Selecting Position of Camera Back When Using Rotating Slide Adapter

The camera back can be rotated in 90-degree increments in either of two ways. First, the rotating slide adapter can be rotated by lifting the rotating slide latch. This permits the tracks on the rotating slide adapter to run either vertically or horizontally. This in turn allows the camera back to slide either way. The camera back itself can also be rotated by sliding it off the rotating slide adapter, rotating it, and sliding it on the rotating slide adapter in the new position.

If either of these methods is used, you must place the dark slide into the camera before rotating the camera back in order to prevent exposing the film.

For most applications involving only single exposure per frame, it will normally be most convenient to install the rotating slide adapter so that the tracks run horizontally. The slide index lever can be either on top or bottom, as desired. Either the long or the short axis of the film can be made to run parallel with the trace by rotating the camera back itself.

When more than one exposure per frame is required, you will probably want to install the rotating slide adapter so that its tracks run vertically. This will permit the film back to move vertically and allow more than one trace to be photographed on a film frame. Again the camera back can be installed with the long axis of the film either parallel or perpendicular to the trace.

GRAFLOK BACK

Focusing With a Graflok Back

Install the Graflok back and press the release button on the back (see Fig. 2-6). Set the lens for maximum aperture (f/1.3, f/1.9, etc., depending on the lens) and set the SHUTTER SPEED selector on Time (T). Obtain a sharply focused trace on the CRT using the oscilloscope Focus and Astigmatism controls. Open the camera shutter and observe the image on the ground glass screen of the Graflok back.

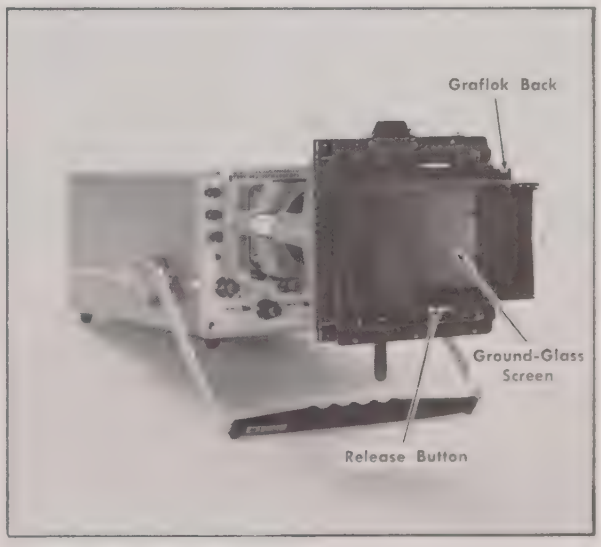


Fig. 2-6. The Graflok Back installed to permit focusing.

Loosen the two set screws (one located on each side of the main frame, see Fig. 2-1), using a $^{5}/_{16}$ inch hexagonal

wrench. Slide the main frame forward or backward until the ground glass image is sharply focused, then tighten the two set screws on the main frame.

The camera is normally focused on the oscilloscope trace rather than the graticule, since it is usually most desirable to photograph the fine detail of the trace. Even with the camera focused on the oscilloscope trace, the focus of an external graticule will usually be quite satisfactory. The camera can, of course, be focused on the external graticule if desired.

CONVENTIONAL FILM HOLDERS

Loading the Sheet Film Holder

Sheet film is available in a variety of types. Some types of film require that the film holders be loaded in complete darkness, while others permit the use of a safe light. See the instruction sheet with the film; it will state whether a safe light can be used or not.

In loading the film holder, the dark slide (see Fig. 2-7) should be pulled out about half way. Place the silver side of the slide handle in the empty film holder to be loaded, towards the closest outside surface. Later, when the sheet of film has been exposed, turn the slide over so that the black side of the handle faces the outside when it is re-installed.

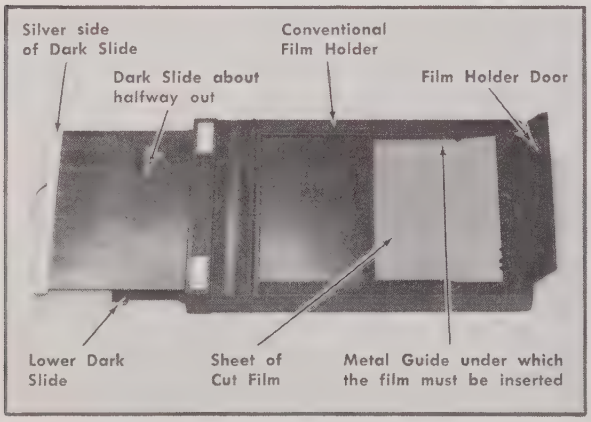

Silver side of Dark Slide
Conventional Film Holder
Dark Slide about halfway out
Film Holder Door
Lower Dark Slide
Sheet of Cut Film
Metal Guide under which the film must be inserted

Fig. 2-7. Important points of film holder.

The following procedure should be practiced several times outside the darkroom before attempting to load the film holders in the dark.

Set the lighting conditions of the darkroom as described in the information sheet which came with the film. Hold the film holder in your left hand with the side which is to be loaded up, and the dark slide toward your body. The index finger of the left hand, is used to hold the film holder door open. Refer to Fig. 2-8 for the method used.

With the right hand, hold the film so that the notches in the edge of the film are in the upper right corner. Fig. 2-9 shows the proper way to hold the film. In Fig. 2-9 it should be noted that the index finger of the right hand is resting on the notches in the film.

The film is inserted at a slight downward angle into the holder. Fig. 2-9 shows how the film must be inserted under the two metal guides inside the film holder. After the film is started under the metal guides, it should be shoved all the way forward in the holder (toward the body). If the film is not shoved all the way forward, the complete image may not appear on the film.

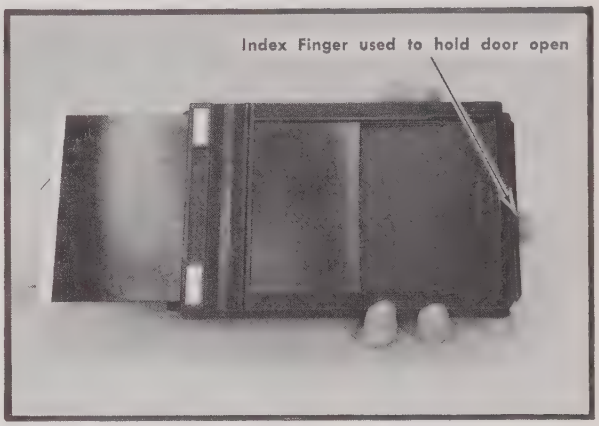


Fig. 2-8. Method used to hold film holder while loading the film.

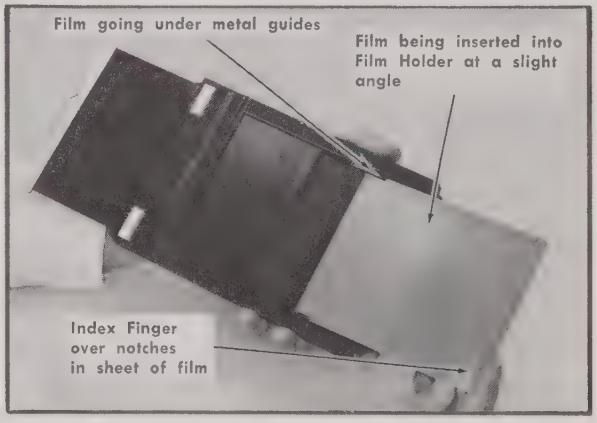

Film going under metal guides
Film being inserted into Film Holder at a slight angle
Index Finger over notches in sheet of film

Fig. 2-9. Proper way to insert the film into the film holder. Note the position of the right index finger on the sheet of film.

When the film is inserted into the holder, the far end of the film should be given a flick with the index finger of the right hand, see Fig. 2-10. This will indicate whether the film is under the film holder guides or not. Now that the film is properly installed in the film holder, the film holder door may be closed.

Release the index finger of the left hand from holding the door open, and with the right thumb close and hold the door in the closed position, (see Fig. 2-11). Now push the slide

all the way into the holder (toward the film door). The dark slide will slide into a slot in the film holder door when it is shoved all the way into the holder. One side of the film holder is now loaded. The film holder door will remain closed by itself once the dark slide has been inserted all the way.

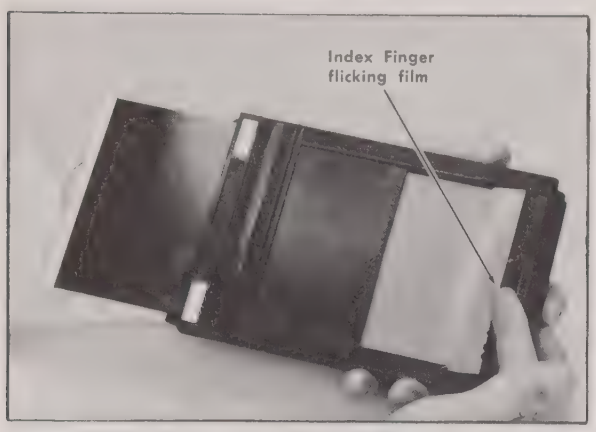


Fig. 2-10. Checking the sheet of film to insure that it has been inserted under the metal guides of the film holder.

Fig. 2-11. Closing the film holder after loading the sheet of film. The film holder door is held closed with thumb while dark slide is installed.

The dark slide may now be locked in place by turning the right angle pin located on the end of the film holder toward your body.

Procedure Used to Expose Sheet Film

Obtain the desired waveform on the oscilloscope and, with the Focus and Astigmatism controls, focus the display. The camera should now be attached to the oscilloscope and the Graflok back attached to the camera.

Set the APERTURE selector for the largest lens opening and the SHUTTER SPEED selector to the (T) position. Now depress the SHUTTER RELEASE lever to open the shutter. Open the ground glass viewing doors and check the focus of the camera.

With one hand take the film holder, and with your free hand lift the hinged focusing panel on the Graflok back (see Fig. 2-12). Insert the film holder between the hinged focusing panel and the other part of the Graflok back. The side of the film holder to be exposed should be installed toward the camera lens.

The film holder should be firmly shoved all the way into the Graflok back until the small ridge on the film holder is seated in the Graflok back. Test to see that the film holder is seated by giving it a slight tug.

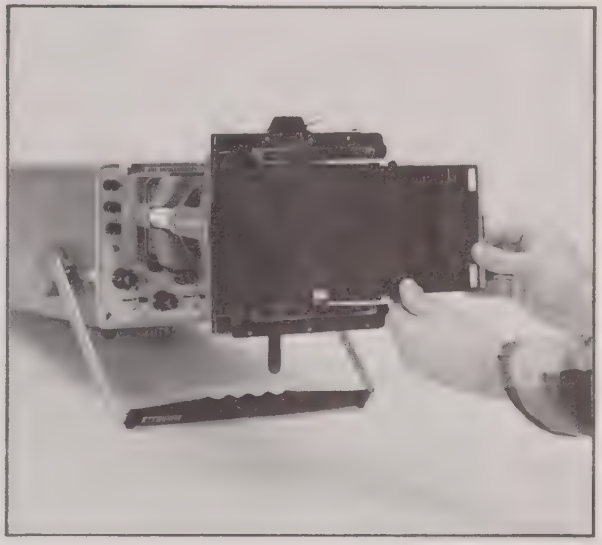


Fig. 2-12. Inserting the film holder in the Graflok back.

Close the shutter and set the APERTURE selector and SHUTTER SPEED selector to the desired settings. Remove the dark slide from the side of the film holder facing the lens. Expose the film and replace the dark slide in the film holder so that the black side of the handle is toward the camera lens. The black side of the dark slide toward the nearest outside edge of the film holder indicates exposed film.

To remove the film holder from the Graflok back, the hinged focusing panel must be lifted away from the camera slightly. With the hinged focusing panel lifted, take hold of the film holder, lift it slightly and pull outward.

To remove the sheet film from the film holder, reverse the loading procedure as described above.

Loading Roll Film Holder

If the directions for loading the roll film holder have been lost, the sectional drawing (Fig. 2-13) may be used as a guide. Fig. 2-14 shows the various parts of a 120 size roll film holder. Make sure the dark slide is installed in the roll film holder before advancing the film for the first exposure.

Attaching Roll Film Holder to Graflok Back

The roll film holder should be loaded before installing it on the Graflok back. After the roll film holder is loaded and the film advanced to the first exposure (dark slide still installed), it can be laid aside.

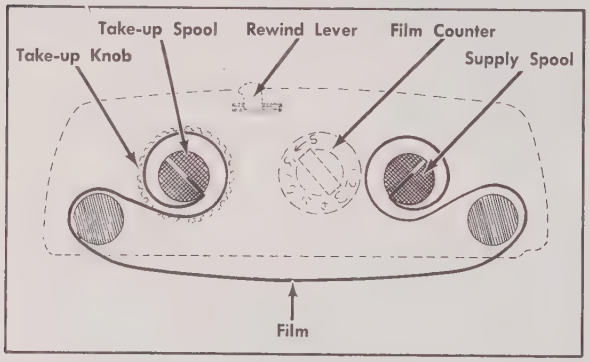


Fig. 2-13. Film threading path for a typical roll film holder.

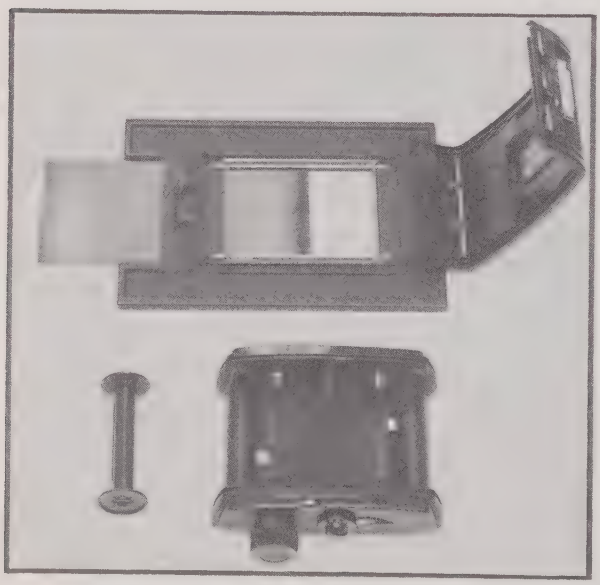


Fig. 2-14. Typical Roll Film Holder apart, ready to load film.

Install the Graflok back on the camera and mount the camera on the oscilloscope.

Place one thumb on each of the hinges for the hinged focusing panel (refer to Fig. 2-15). Press the hinges in toward the oscilloscope, and at the same time, slide the hinged focusing panel toward the side in which the film holder would be inserted. The above procedure will remove the hinged focusing panel from the Graflok back.

Slide the roll film holder onto the Graflok back. Sliding the roll film holder on will insure a light-tight seal. The small ridge on the roll film holder should fit into the slot in the Graflok back. This is the same type of locking used on the sheet film holder.

With one hand, hold the roll film holder on the Graflok back, and use the other hand to engage the two slide locks. One slide lock is located on each side of the long axis of the film (see Fig. 2-16).

Fig. 2-15. Method used to remove the Hinged Focusing Panel.

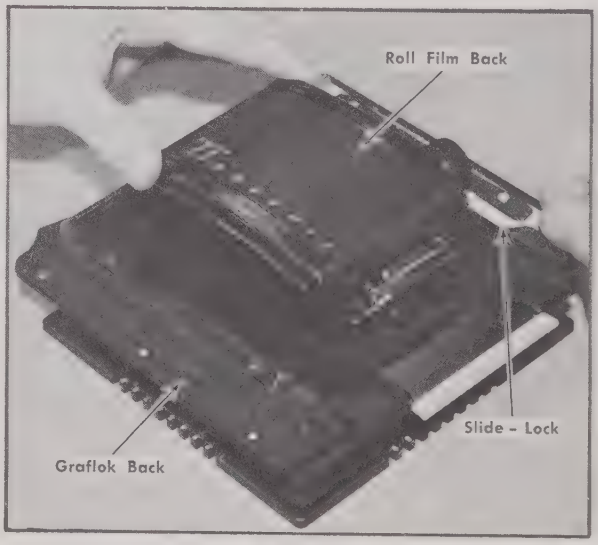


Fig. 2-16. Installing the roll film back on the Graflok back.

Exposing Roll Film

Obtain the waveform on the oscilloscope and focus it properly. The camera should already be in focus. If it is not, the hinge focusing panel must be re-installed for focusing. Remove the dark slide from the roll film holder, set the SHUT-

TER SPEED selector and APERTURE selector to the proper settings and take the picture.

To advance the film, press the film release lever and turn the knob until it stops. The roll film holder is now ready for the next exposure.

POLAROID LAND 4 × 5 FILM HOLDER

Attaching Polaroid Land 4 × 5 Film Holder to Graflok Back

Install the camera on the oscilloscope to be used and attach the 4 × 5 Graflok back to the camera. The waveform should be obtained and focused properly with the oscilloscope controls. Check the camera focus with the aid of the ground glass in the Graflok back.

To insert the film holder in the Graflok back, lift the hinged focusing panel and slide the film holder between the hinged focusing panel and the rest of the Graflok back. The film holder should be inserted so that the precessing arm is facing away from the lens (see Fig. 2-17).

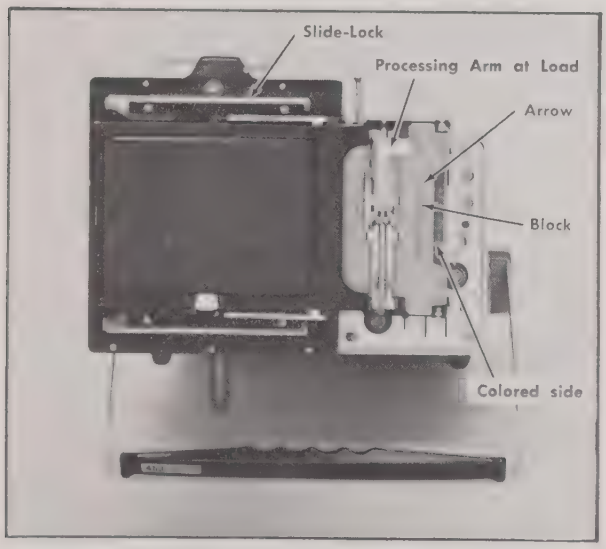


Fig. 2-17. Polaroid and 4 × 5 film holder properly installed in the 4 × 5 Graflok back. With the film packet properly installed, it should be as shown.

When the film holder has been shoved all the way into the back, give a slight tug outward to see if the unit is firmly locked in the Graflok back. There is a small ridge on the holder which will engage in a slot in the Graflok back. Lock the film holder in place by engaging the slide locks into the slots in the film holder (refer to Fig. 2-17).

NOTE

The weight of this film holder makes it advisable to use the slide locks in addition to the spring back to prevent light leaks, and to hold the film holder securely.

Inserting and Exposing Polaroid Land 4 × 5 Film Packet

When inserting the film packet, the precessing arm on the Polaroid Land film holder must be in the LOAD (up) position. Before inserting, check the film packet for the proper side toward the lens. The packet should be inserted into the film holder so that the colored block and the arrow are on the side of the film packet that faces you (away from the lens).

Hold the film packet at about its center and insert the metal-capped end into the holder. Push the film packet gently (without buckling) into the film holder. After the metal-capped end has been pushed past the rubber roller, you should shift your holder to the far end (colored block and arrow end) of the packet.

NOTE

Do not press on the pod area of the film packet. The pod contains developing chemicals and premature rupture will damage the picture.

The packet should be pushed into the film holder until it stops. When the film packet is inserted all the way into the film holder the arrow and the colored block should just show (refer to Fig. 2-17).

Set the SHUTTER SPEED selector and the APERTURE selector to the proper settings for the picture. When you are ready to take the picture, gently pull the film packet envelope out of the holder until it stops. The envelope acts as a dark slide. A slight resistance will be felt as the envelope detaches from the metal end cap as you start to pull the envelope out of the film holder. To avoid fogging the negative, the envelope should not be withdrawn for a longer period of time than necessary.

Make your exposure as you would normally. The ASA rating of the film, along with other directions, will be found inside the film box. When the film packet envelope is pulled out for an exposure, take care not to bend the envolope out of its natural position. Such a bend could cause light leaks.

After the exposure has been made, re-insert the envelope all the way into the film holder. Using the colored block and arrow, the envelope may be checked to insure that it is all the way inserted. If the envelope will not re-insert all the way, withdraw it and try again. Forcing of the film envelope can cause buckling and creasing of the print.

The picture may be developed right away or at a later time. If ambient humidity is high, development should not be delayed.

Developing the Film Packet

Immediate Development. After the envelope has been re-inserted into the film holder, swing the processing arm on the Polaroid Land 4 × 5 film holder to the PROCESS (down) position. This will cause the processing rollers to come together. Now, when you pull the packet out of the film holder, the rollers will crush the pod and spread the developing reagent between the positive and negative sheets inside the packet.

To start development of the film packet, pull the film packet all the way out of the film holder with a confident

and fairly rapid motion. A slight resistance will be encountered as the metal cap enters the rollers, but keep right on pulling without hesitation. The picture is now developing. Refer to the directions packed with the film for the recommended development time.

Extremes of pulling speed shoud be avoided in pulling the film packet out of the film holder to start development. A slow, inching pull may cause mottle or streaks to appear on the print, while too fast a pull may result in an uneven spread of the developing reagent.

Care should be taken to prevent the film packet from bending or buckling during the development time. If possible, the film packet should be laid on a flat surface. Once the film packet has been pulled out to start development, the processing arm should be thrown to the LOAD (up) position. The film holder may now be reloaded for the next picture.

Removal of Finished Picture. After the recommended development time, remove the envelope of the film packet by hooking the tips of your fingers under the edge of the metal cap while you give the envelope a moderate tug with the other hand, from the colored block and arrow end. Use the finger tips only, and let the thumb rest along the edge of the metal cap. Do not try to pry off or bend the metal cap.

Peel the Picture away from the negative. Take the white sheet in one hand, the brown paper and negative in the other, and peel them apart rapidly. Do not let the print fall back on the damp negative. Black-white pictures should be coated as soon as possible, using print coaters supplied with each box of packets. Follow coating instructions found on the instruction sheet in the film box.

If Type 55 P/N Polaroid Land film has been used, the brown paper should be removed from the negative as soon as possible. Also remove the metal cap, developer pod and the black paper tab from the negative. The negative must now be washed in water or a solution of sodium sulfite and then dried. Refer to the instruction sheet in the film box for complete directions.

Removal of Exposed Film Packet for Later Development. Occasionally you may want to expose a series of pictures without developing each one right away. Here's how to remove the film packet without developing.

After exposing the negative and re-inserting the envelope all the way, make sure the processing arm is in the LOAD (up) position.

Push the release lever on the far end of the film holder (end away from loading end) as far down as it will go (about $\frac{3}{8}$ inch) and hold it down. Briskly pull the film packet out of the film holder. Do not let go of the release lever until the film packet is completely out of the film holder.

To identify the exposed but unprocessed packets, bend over one corner (away from the metal cap). This will prevent mix-ups when shooting fast.

Developing Exposed Film Packets at a Later Time. With the precessing arm in the LOAD (up) position, insert the exposed packet into the film holder as described previously. Make sure the packet is fully inserted into the film holder. Swing the processing arm to the PROCESS (down) position and proceed to develop your pictures in the manner outlined above.

POLAROID LAND ROLL FILM BACK

Focusing Camera with Focusing Plate

To use the focusing plate, the Polaroid Land Camera back must be opened and the focusing plate inserted where the film normally rests. Fig. 2-18 shows the focusing plate properly installed.

When installing the focusing plate, insert the two bottom ears inside the edge of the camera-back film compartment. With nothing more than finger pressure, gently press the upper mounting ears into the film compartment. The upper mounting ears will have to be compressed and the focusing plate inserted into the film compartment at the same time.

NOTE

For the focusing plate to operate properly, the frosted side must be towards the camera lens and flush with the normal film position.

When focusing the camera, be sure to set the lens for maximum aperture (f/1.3, f/1.9, etc., depending on the lens) and set the SHUTTER SPEED selector on (T). Obtain a sharply focused trace on the CRT using the oscilloscope Focus and Astigmatism controls. Then secure the camera in place on the oscilloscope. Open the camera shutter and observe the image on the focusing plate. Loosen the two set screws (one located on each side of the main frame, see Fig. 2-1), using a $\frac{5}{16}$ inch hexagonal wrench. Slide the main frame forward or backward until the ground glass image is sharply focused, then tighten the two set screws on the main frame.

The camera is normally focused on the oscilloscope trace rather than the graticule since it is usually most desirable to photograph the fine detail of the trace. Even with the camera focused on the oscilloscope trace, the focus of an external graticule will usually be quite satisfactory. The camera can, of course, be focused on the external graticule if desired.

Loading and Exposing Roll Film Back

When a new box of film is opened, the instruction sheet and print coater should be saved.

To open the camera back for loading, swing the latch lever out and down from the bottom of the camera back. The back should have opened slightly. Now swing the back cover out until it is fully open. Inside the camera back, you will see the inner panel. Swing the inner panel to its fully opened position.

Remove the empty spool from the camera back. The processing rollers in the camera should be inspected and cleaned if necessary. A damp cloth may be used to clean the rollers. It is important to keep these rollers clean to spread the developer evenly between the negative and positive components of the film.

In the following procedure, it is assumed that the camera back is lying face down on a table, with the dark slide protruding from the right side (tripod socket hole toward you).

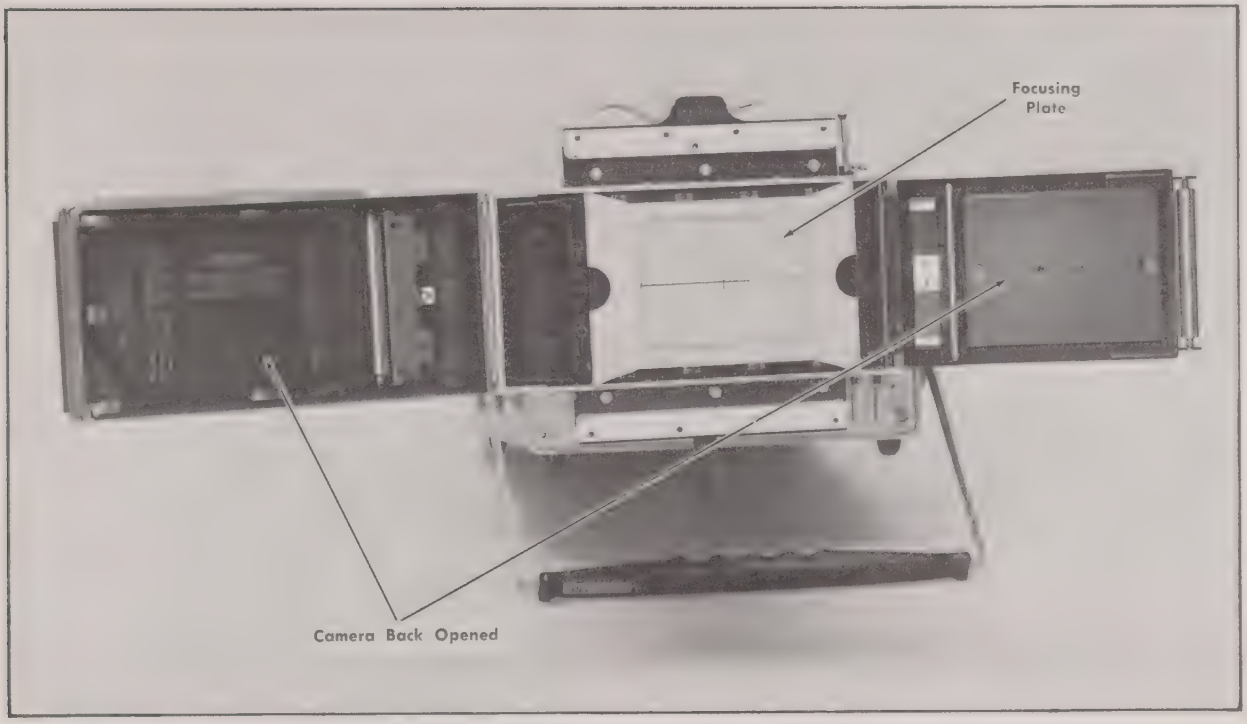


Fig. 2-18. Focusing Plate placed in the proper position fo focusing.

Remove the film rolls from the foil wrapper by tearing the wrapper at the indicated point. Break the first seal at the end of the roll. The film actually contans two rolls: a large white positive roll and a smaller spooled negative roll. When you unwrap the film, be careful not to break the seals on the top of the negative roll and the under side of the positive roll. Drop the rolls into the wells in the camera back as shown in Fig. 2-19.

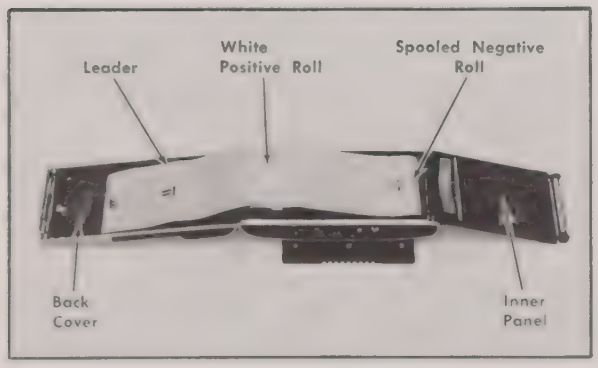


Fig. 2-19. The Polaroid Roll Film Camera Back opened for loading. The white positive roll is dropped in the well at the left while the spooled negative roll is dropped in the well at the right.

Close the inner panel, bringing the film leader around the steel roller on the edge of the inner panel. Lay the leader flat between the guides at the outer edge of the panel (see Fig. 2-20). Be sure that the white paper of the positive roll lies smooth and flat, not tucked into the well.

Close the back cover, and squeezing it tightly shut, pick up the camera back. Swing the latch lever all the way towards the bottom of the camera back. This will insure that both sides of the back cover will latch. Swing the latch lever to the locked position (towards the top of the camera back). There should now be a short tab of paper extending beyond the cutter bar of the camera back. The dark slide should be installed in the camera back. If it is not, the first picture may be exposed.

While holding the camera back with your left hand, lift the cutter bar with your right hand. The cutter bar is lifted by raising up the plastic edge. Once the cutter bar has been lifted, it will remain in the up or unlocked position until it is pushed down. Pull the film leader out of the camera back until it comes to a firm stop. About 15 inches of film leader must be pulled out before it will stop, but this will occur automatically when the film is in the proper position for the first exposure.

Lock the cutter bar with a gently downward pressure. After it has latched you can tear the film leader off and discard it.

The camera back is now ready for the first picture. Mount the camera back on the rotating slide adapter and make the proper shutter and lens opening settings. Remove the dark slide and take the picture. The number of exposures remaining on the roll is indicated on the film tab under the cutter bar.

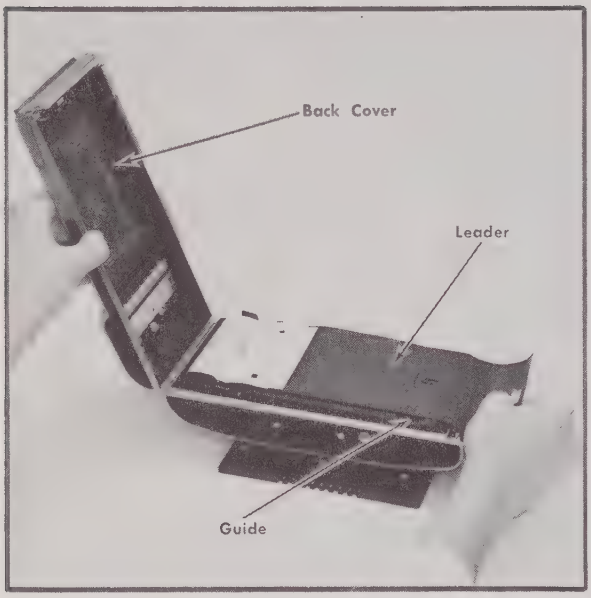


Fig. 2-20. The leader of the film roll must be brought around the roller on the inner panel. Care must be taken that the leader is aligned between the guides on the inner panel before the back is closed.

Advancing and Developing the Roll Film

Throw the red release switch in either direction to release the film. If you should throw it accidentally at any time, no harm is done. Open the cutter bar by lifting the plastic edge, and take a firm grip on the film tab.

Pull the film tab straight out about 7 inches with a single motion. Pull it about as hard and rapidly as you might pull down a window shade; not hard enough to pull the shade off the roll (or the film off the spool), but not slowly and hesitantly. Remember, the film will stop automatically.

NOTE

If the film tab will not pull easily, throw the red release switch again.

After you pull the film tab, press down and latch the cutter bar. Tear off and discard the excess paper.

Wait the recommended development time. Pulling the film tab has started development process and advanced the film into position for the next picture. Follow the instructions in the instruction sheet for development times under various conditions. It is important to check the instruction sheet for exact development time. This time varies for different types of film, and even the development time for a particular film may change.

When the development time is up, slide back the latch on the print door and open the door. Lift the print out carefully, starting with the cutout. Don't let the print fall back on the damp negative. Then close and relatch the print door.

Coat each black-and-white print as soon after removal from the back as possible. First remove the curl by drawing the print face up, over a straight edge, such as the edge of the cutter bar.

Apply the print coater along the entire length of the print, including edges, borders and corners, with 6 to 8 firm over lapping strokes. For the last two or three pictures in each roll press the coater down hard against the tab end of the print (not the image) for a moment to release extra liquid; then spread the liquid smoothly across the print.

POLAROID LAND PACK FILM CAMERA BACK

Focusing the Camera with the Focusing Plate

To use the focusing plate, the Polaroid Land pack film camera back must be opened and the focusing plate inserted where the film normally rests. Refer to the paragraphs under Loading and Exposing the Polaroid Land Film Pack for directions on how to open the camera back. Fig. 2-21 shows the focusing plate properly installed.

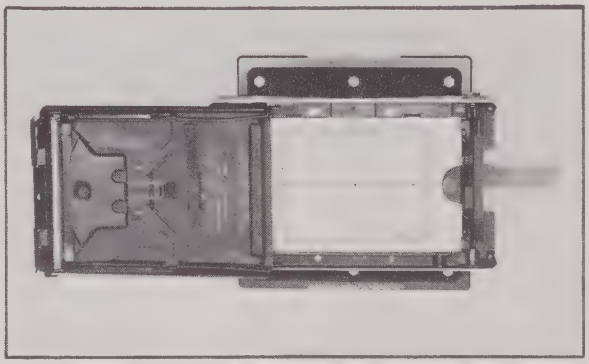


Fig. 2-21. Focusing Plate installed in Pack Film Camera Back.

When installing the focusing plate, insert the two ears under the door hinge and down next to the exposure window. With nothing more than finger pressure, gently press the focusing plate in the direction of the hinge, at the same time pressing the focus plate in toward the film plane. The half-moon cutout in the end opposite the ears provides a finger hold for easy removal of the focusing plate.

NOTE

For the focusing plate to operate properly, the frosted side must be towards the camera lens and pressed all the way into the film plane.

When focusing the camera be sure to set the lens for maximum aperture (f/1.3, f/1.9, etc. depending on the lens) and set the SHUTTER SPEED selector on (T). Obtain a sharply focused trace on the CRT using the oscilloscope Focus and Astigmatism controls. Then secure the camera in place on the oscilloscope. Open the camera shutter and observe the image on the focusing plate. Loosen the two set screws (one located on each side of the main frame, see Fig. 2-1), using a $5/16$ inch hexagonal wrench. Slide the main frame forward or backward until the ground glass image is sharply focused, then tighten the two set screws on the main frame.

Loading and Exposing the Polaroid Land Film Pack

When the film box is opened, the instruction sheet, film box, and print coater should be saved.

To open the camera back for loading, push the latch lever (on the bottom of the camera back near the tripod socket, see Fig. 2-22) counterclockwise. The door should have opened slightly. Now swing the door out until it is fully open.

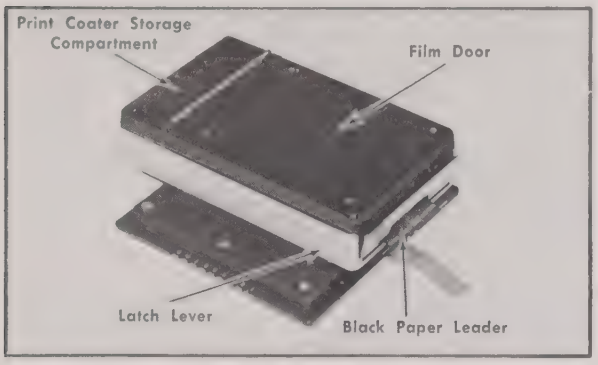


Fig. 2-22. Polaroid Land Pack Film Camera Back.

Remove the empty film container from the camera back by lifting up and pulling it out from under the door hinge.

The processing rollers in the camera back should be inspected and cleaned if necessary. Directions inside the door indicate how to release the stainless steel rollers from their normal position in the camera back. A damp cloth may be used to clean the rollers. It is important to keep these rollers clean to spread the developing reagent evenly.

In the following procedure it is assumed that the camera back is lying face down on a table, with the dark slide protruding from the right side (tripod socket toward you).

Remove the film pack from the foil wrapper by tearing the wrapper at the indicated point. When you unwrap the film, be careful to handle the film pack by the edges only.

Insert the film pack under the back door hinge, and push it toward the hinge and down into the film plane until it snaps into place, see Fig. 2-23. Be sure that the indicated side of the film pack is correctly oriented toward the lens, or the dark slide in this case. The black paper leader should be allowed to hang over the right end of the camera back.

Close the door by squeezing it until both sides snap shut. Make sure the black paper leader is extending outside the camera back, see Fig. 2-22. The dark slide should be pushed in all the way.

While holding the camera back with your left hand, pull the black paper leader all the way out. The camera is now ready for the first picture. If the dark slide has not been pushed in all the way, the first exposure may be fogged.

Mount the camera back on the rotating slide adapter and make the proper shutter and lens opening settings. Remove

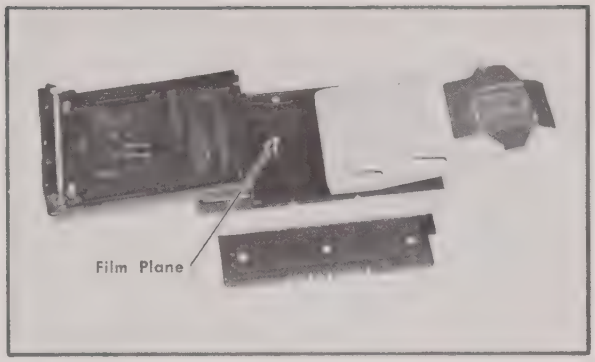


Fig. 2-23. Installing Film Pack into Camera Back.

the dark slide and take the picture. The number of the negative ready for exposure is indicated on the white tab protruding from the camera back.

Advancing and Developing the Film

After taking the picture, pull the white tab which extends from the camera back, see Fig. 2-24, all the way out. Pulling the white tab does two things: first, it positions the positive and negative sheets together; and second, it causes the yellow tab (marked PULL) to pop out.

NOTE

Do not pull another white tab if a yellow tab is extending from the camera back. The white tab should be the only tab visible when it is pulled.

Next pull the yellow tab, see Fig. 2-24. This causes the positive and negative sheets to be pulled between and through the processing rollers, spreading the developing reagent between the two sheets to start the development process.

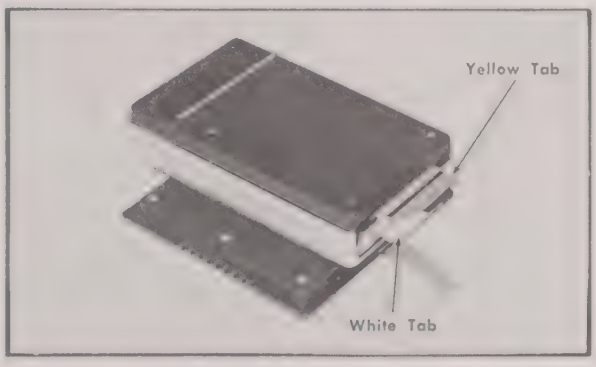


Fig. 2-24. Positive and negative sheets ready to be pulled out of camera back.

Pull the yellow tab completely out of the camera back in one smooth, fairly rapid motion. Pull about as hard and

rapidly as you might pull down a window shade; not slowly and hesitantly.

Wait the recommended development time. Follow the directions in the instruction sheet for development times under various conditions. It is important for you to check the instruction sheet for exact development time. This time varies for different types of film, and even the development time for a particular film is subject to change.

When the development time is up, peel the print away from the negative rapidly. Do not let the print fall back on the damp negative.

Coat each print as soon as possible after separating it from the negative. Prints may be coated by sticking the back of the print to a sticky area to hold them, then using the Polaroid print coater (see instructions on film box).

Apply the print coater along the entire length of the print, including edges, borders and corners, with 6 to 8 firm overlapping strokes. For the last two or three pictures in each film pack, press the coater down hard against a non-image surface for a moment to release extra liquid; then spread the liquid smoothly across the print as before.

Storage of Print Coater

The print coater can be stored in the compartment just to the left of the film loading door (bottom of camera back towards you). To open the compartment, grasp the black cover area to the left of the hinge and lift up. If the compartment is difficult to open, pry with your fingernails between the black cover and the aluminum casting on the left side of the body.

SHUTTER ACTUATOR MODEL 3

Mounting

Power Supply Frame

Refer to rear frame information in this section.

Power Supply Model 3 and Power Supply Mounting Bracket

Grasp the power supply so that the front panel is toward you and the top of the power supply is down. With the power supply in this position, remove the two bottom screws. Lay the mounting bracket on the supply so the flat surface of the bracket is against the supply and the plastic knob is towards you. Line up the slots in the bracket so they are over the holes in the power supply from which the two bottom screws were just removed. When the slots and screw holes are lined up, re-insert the two bottom screws through the slots into the power supply cabinet. Do not tighten the screws at this time.

Power Supply Model 3 (box style) is mounted on a camera back by inserting the screw supplied with the power supply mounting bracket through the proper hole in the bracket and into the tripod socket on the bottom of the camera back. The proper hole to mount the power supply mounting bracket to the camera back is shown in Fig. 2-25.

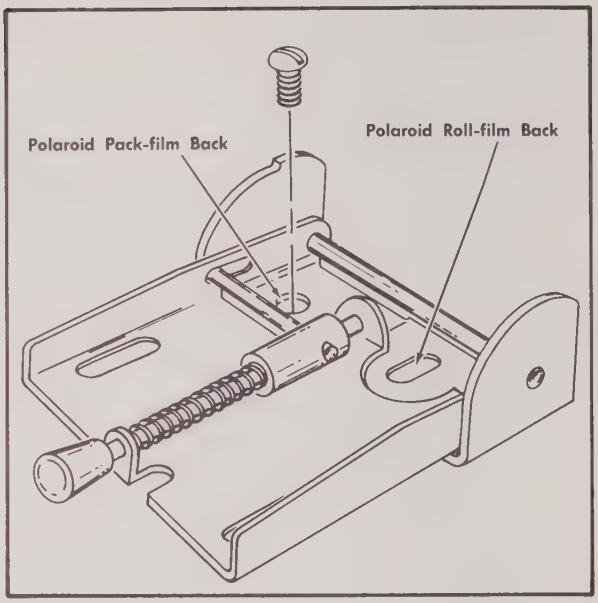


Fig. 2-25. Selecting proper mounting hole in Power Supply Mounting Bracket.

After securing the power supply mounting bracket to the camera back, push the power supply toward the camera back until the rubber feet rest against the camera back. The two bottom screws holding the bracket to the power supply are not tightened.

When it is necessary to open the camera back, the power supply may be rotated out of the way. The power supply is unlocked from its position by pulling back the plastic knob. Keep the knob pulled back (away from the camera back) and rotate the power supply out and down. Release the knob and allow the power supply to rotate into its down position. After the camera back is closed again, the power supply is rotated back to normal position by pushing it up and in toward the camera. The power supply locks into position automatically.

Shutter Actuator Solenoid

Take the shutter actuator solenoid and loosen both of the set screws found between the main part of the body and the knurled nut. The set screws should be loosened only enough to allow the knurled nut to turn freely.

Hold the shutter actuator solenoid directly above the cable release connector on the shutter. Turn the knurled nut to screw the shutter actuator solenoid onto the cable release socket; or as an alternative method, loosen the set screws enough to permit the knurled nut to be removed from the shutter actuator solenoid body. The knurled nut is then screwed onto the cable release socket. After screwing the nut portion onto the cable release socket, remount the shutter actuator body onto the knurled nut. If the shutter actuator body will not remount onto the knurled nut portion, refer to the note below. After remounting the body onto the knurled nut, one or both of the two set screws used to retain the knurled nut must be tightened.

NOTE

It may be necessary to partly rotate the lens to allow the shutter actuator solenoid to be mounted. The slight unscrewing of the lens should not exceed ½ turn. This small amount will not materially affect the object-to-image ratio of the lens, but will affect the focus of the camera; therefore, the camera must be refocused. When it is necessary to rotate a lens of the type that is mounted with a locking ring, the locking ring may be loosened slightly and the lens rotated 180°. A lens using the locking ring will not show any change in the object-to-image ratio or focus after the lens rotation.

CAUTION

If the camera system is to be subjected to shock in excess of 10 g for 10 to 20 milliseconds, the shut-actuator solenoid should be removed from the shutter. Failure to remove the shutter actuator solenoid will cause damage to the shutter.

Special Instructions for Ilex 'Elgeet No. 3X Universal Shutters

The SHUTTER RELEASE control, on early lenses using the Ilex (Elgeet) No. 3X Universal shutter, can come in contact with the knurled nut that attaches the shutter actuator solenoid to the shutter. This interference will prevent operation of the shutter. To correct this difficulty, bend the SHUTTER RELEASE control to provide clearance between it and the knurled nut. Care should be exercised in bending the SHUTTER RELEASE control to ensure that it is bent only enough to obtain clearance between it and the knurled nut, and the control has free operation over its full travel.

To bend the SHUTTER RELEASE control, grip it with long-nose pliers adjacent to the shutter housing; see Fig. 2-26. Bend the control over the long-nose pliers using finger pressure only.

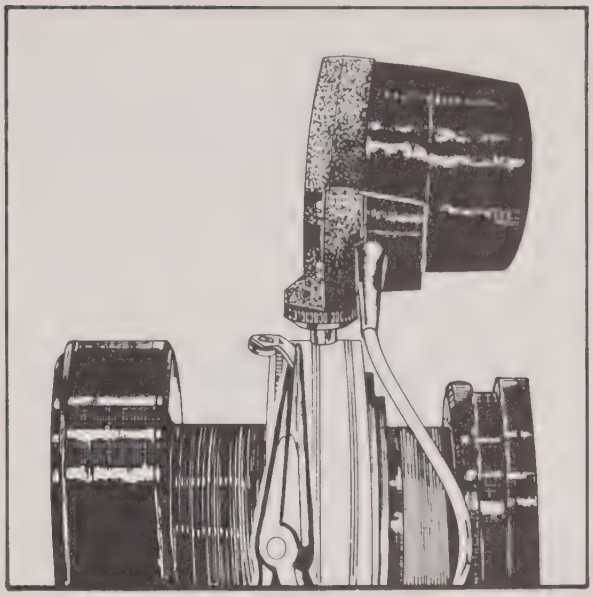


Fig. 2-26. Placing of long nose pliers prior to bending Shutter Release Lever on Ilex (Elgeet) No. 3X Universal shutter.

Operating Controls and Connectors

ACTUATOR (Indicator Lamp) — Lights when the shutter actuator solenoid is energized. The lamp will stay lit as long as the actuator is held energized. The lamp is an indicator that the shutter is open if the SHUTTER SPEED selector is set on (B). The lamp is not, however, an indicator that the shutter is open if the SHUTTER SPEED selector is set on (T).

The ACTUATOR lamp mounted on the power supply frame can be remotely located. To remotely locate the lamp, unplug the neon assembly and make an extension cord.

ON-OFF — Turns the line voltage to the power supply on or off.

POWER — Indicator lamp lights when line-voltage is applied to the power supply.

MOMENTARY-OFF-MAINTAIN — Causes the shutter actuator solenoid to be energized in the MOMENTARY or MAINTAIN positions.

The MOMENTARY is a spring return to OFF position while the MAINTAIN position allows the shutter actuator solenoid to be held in the energized position indefinitely.

REMOTE — Applying 24 VDC to the + and — pins of the REMOTE connector will energize an internal relay whose normally open contacts are connected across the MOMENTARY - OFF - MAINTAIN switch. The energizing of the internal relay will cause its normally open contacts to close, which will simulate holding the MOMENTARY-OFF-MAINTAIN switch in its MOMENTARY position. As long as 24 VDC is applied to the + and — pins of the REMOTE connector the shutter actuator solenoid will remain energized.

NOTE

Voltage polarity should be observed when several shutter actuator units are being triggered simultaneously from the same 24 VDC source.

Power Cord — The power cord to the power supply is permanently attached. In the case of the power supply frame, this allows the power cord connection to be made light-tight.

Actuator 115 (230) VDC 1 A (.5 A) — Receptacle into which the connector from the shutter actuator solenoid connects to obtain operating power.

Operating Shutter Actuator Model 3

NOTE

To prevent a misleading display on the oscilloscope, the leads of the shutter actuator system should not be interwound with the input leads to the oscilloscope. Maximum separation of the leads is recommended, since there is a magnetic field present when the shutter actuator solenoid is energized.

Repetitive Waveforms

Mount the shutter actuator solenoid and power supply on the camera as described under Mounting, then mount the camera on the oscilloscope.

1. Apply line voltage to the power supply after connecting the shutter actuator solenoid, then set the SHUTTER SPEED selector to (B).

2. Energize the shutter actuator solenoid by turning the ON-OFF switch to ON and the MOMENTARY-OFF-MAINTAIN switch to MAINTAIN.

3. Focus the camera.

4. After focusing the camera, return the MOMENTARY-OFF-MAINTAIN switch to OFF.

To photograph a repetitive waveform using any shutter setting other than (T) or (B), first obtain a stable display of the desired waveform on the CRT. Second, with the camera back ready for exposure, push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY and release.

To photograph a repetitive waveform using a shutter setting of (T), the MOMENTARY-OFF-MAINTAIN switch must be pushed twice to the MOMENTARY position. The first time the switch is pushed to MOMENTARY, the shutter will open. The second operation will close the shutter.

To photograph a repetitive waveform using a shutter setting of (B), the MOMENTARY-OFF-MAINTAIN switch must be held in the MOMENTARY position for the desired exposure time and then released.

Non-repetitive Waveforms

Mount and focus the camera system as outlined above under Repetitive Waveforms.

When photographing a non-repetitive waveform using a shutter setting of (T), set the oscilloscope for single-sweep operation so that the display, when presented, will not have jitter. Push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY and release. Wait for the waveform to occur, then push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY again and release. This last action closes the shutter.

When using a shutter setting of (B) to photograph a non-repetitive waveform, set the oscilloscope for single-sweep operation. Then set the MOMENTARY-OFF-MAINTAIN switch to MAINTAIN. After the waveform has occurred, the MOMENTARY-OFF-MAINTAIN switch is set to OFF to close the shutter.

NOTE

The Shutter Actuator System Model 3 may be left in the MAINTAIN (energized) position for an indefinite period without damaging the equipment.

SECTION 3

PHOTOGRAPHIC TECHNIQUES

CAMERA-OSCILLOSCOPE CONSIDERATIONS

Writing Rate

Writing rate is a figure of merit which roughly describes the ability of a particular camera system mounted on a particular oscilloscope to photograph fast-moving traces. The writing rate figure expresses the maximum spot rate (usually in centimeters per microsecond) which can be photographed satisfactorily.

The faster the oscilloscope spot moves, the dimmer the trace becomes. This is because the electron beam strikes each point of the phosphor coating for a shorter period of time. A camera system and oscilloscope which have a high writing rate are required for low-repetition-rate displays at the fast oscilloscope sweep rates.

Fig. 3-1 shows one way in which writing rate can be calculated. A single trace of a damped sine wave is displayed. The frequency of the damped waveform is such that the rapidly rising and falling portions of the first cycle or two fail to photograph. The writing rate of the system is found as follows: Starting from the left, find the first rapidly rising or falling portion of the damped sine wave which is photographed in its entirety. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion. If D is three or more times as great as the horizontal distance occupied by one cycle (so that the horizontal component of velocity is small compared to the vertical component), the maximum writing rate in centimeters per microsecond is given approximately by:

$$\text{Maximum writing rate} = \pi \text{ Df}$$

where f is the frequency of the damped wave in megahertz.

It is not practical to speak of the absolute writing rate of any oscilloscope or camera, because so many variables are involved. Among the variables which must be considered are the speed of the camera lens, the type of CRT phosphor, the type of film, the CRT accelerating potential, the camera optical arrangement, the object-to-image ratio of the camera lens, and development time of the film.

It is possible to compare the effectiveness of two films by measuring their writing rate under the same conditions. In other words, you can determine which of the two films is the more effective under those particular conditions without being able to assign a specific value to either film.

The rated ASA speed of a film doesn't tell you much about its effectiveness in recording single oscilloscope traces. This is because the ASA speed rating is measured for 1/50 second exposure to light of normal daylight and spectral characteristics, while the very short exposures of fast CRT traces are several orders of magnitude smaller and have various spectral distributions. There is usually some relationship between ASA rating and maximum writing rate, however. Thus, it would be safe to assume that a film with a very high ASA speed rating would probably have a higher maximum writing rate than a film with a lower ASA speed rating.

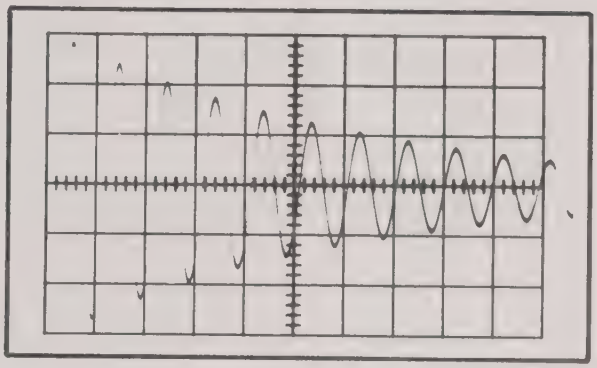


Fig. 3-1. A single-shot damped sinusoidal waveform which can be used to measure the maximum writing rate of an oscilloscope-camera combination.

CRT SELECTION

Selecting the CRT Phosphor

There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications. Of the many types of phosphors available, five are most commonly in use. They are the P1, P2, P7, P11 and P31. Other phosphor types are usually restricted to special applications. Since the P1, P2, P7, P11 and P31 phosphors are the ones most commonly used, information contained in this portion of the manual will primarily concern these phosphors.

For low sweep rate or repetitive-sweep applications where a high writing rate is not required, practically any type of phosphor is satisfactory. It is only for single-sweep or low-repetition-rate applications at the fast sweep rates where selection of the CRT phosphor is important. In low-repetition-rate applications at the fast sweep rates, use of the proper phosphor can mean the difference between getting a good photograph and not getting one at all.

Probably the most important single characteristics of a phosphor for photographic purposes is the color of its emitter light. A blue or violet fluorescence has the highest actinic value, and thus is most suitable for photographic work. In general, it can be stated that (all other things being equal) the shorter the wavelength of the visible peak emitted light, the better the phosphor for photographic applications.

Most users of oscilloscopes are concerned not only with photographing the oscilloscope trace, but in observing it

TABLE 3-1

Common Phosphor Table

Phosphor Type	[1]Writing Rate P11 used as the Standard	[2]Relative Brightness Representative of 10 kV aluminized screens	Wavelength of Peak Radiant Energy	Decay Time in ms to 10% of initial value	Color	
					Fluorescense	Phosphorescense
P1	35% as fast	150	520 nanometers	25	Yellowish-green	Yellowish-green
P2	70% as fast	230	510 nanometers	0.32	Bluish-green	Green
P7	95% as fast	128	450 nanometers	0.34	Blue-white	Yellowish-green
P11	100%	100	450 nanometers	0.28	Purplish-blue	Purplish-blue
P31	75% as fast	390	530 nanometers	0.34	Green	Green

[1]To achieve the writing rate comparisons the shutter of the test camera was left open five seconds to make use of the available light.
[2]Taken with a Spectra Brightness Spot Meter, which incorporates a C.I.E. Standard Eye Filter.

directly as well. For such applications, it is important to have a phosphor which gives good results in both types of applications. This frequently results in the choice of a phosphor such as P2 or P31 where the emitted light has a large enough actinic value to give a good writing rate, and also has sufficient persistence to permit easy viewing.

It has been observed that the P11 phosphor has the highest comparative writing rate of any common phosphor, and is thus best for photographic work. The medium short persistence of the phosphor is somewhat undesirable for general purpose work, but the disadvantages of this are slight. Type P11 should be chosen whenever the ultimate in photographic ability is required. Type P11 emits a medium short-duration blue light.

Since the Type P2 or P31 phosphors appear to be best for combined general purpose use and photographic applications, they are standard on most Tektronix oscilloscopes. Type P11 is standard on Tektronix oscilloscopes where extremely rapid sweeps make it possible to obtain maximum benefit from the advantages of this phosphor. Other phosphors can be obtained on any of the Tektronix oscilloscopes.

FILM SELECTION

Selecting the Proper Film

For most oscilloscope work you will find Polaroid Land film the most convenient. This film permits you to see the picture very soon after taking it, and makes it unnecessary to expose all of the film before developing any of it.

Table 3-2 gives a brief outline of the available emulsions. The films recommended or films having equivalent characteristics may be used.

Helpful Techniques with Film

Polaroid Land Film

Several types of spray-on matte finishes are available which will enable you to make pencil or pen notes directly on the Polaroid prints. It can be obtained from any store handling art or photographic supplies.

Another method of note marking is to use an ink eraser to rub the emulsion off the areas to be written on. Pen or pencil is then used to write the data on the print. This method will not work on the plastic-base films. Still another method of note marking is to scratch the desired data onto the print with a sharp pointed instrument. The data should be scratched onto the print before it is coated.

For greater contrast on Polaroid prints, use slightly longer development time. A decrease in development time, on the other hand, will normally increase writing rate; with, however, a consequent lowering of print contrast. Shorter time will sometimes bring up waveform details not otherwise visible.

A method which sometimes produces very good results with Polaroid Land films is prefogging. In prefogging, the film is exposed to a predetermined amount of light for a definite period. The intensity of the light and the period of the exposure are so chosen that the film is brought just to the threshold of being exposed. A lesser amount of light is then required to expose the film. The prefogging technique can produce an increase in maximum writing rate of two or more times depending on film type, film condition, the nature of prefog light and other variables. Prefogging results in a slightly foggy background on the photographs and somewhat less contrast. This is a small price to pay for a large increase in writing rate, however.

Postfogging is very similar to prefogging. The difference is that the film is exposed to the controlled light source after the exposure, rather than before. Postfogging produces very nearly the same increase in writing rate as prefogging.

Transillumination

While not strictly a means of improving writing rate, transillumination permits you to better see information which is recorded on prints. In the technique of transillumination, the print is observed with a source of bright diffused light, such as a light bulb, directly behind the print (see Fig. 3-2). The light passing through the print brings out detail which would not otherwise be evident.

The transillumination technique will not work on the one-hundred series or colored Polaroid film since these are on a plastic base.

TABLE 3-2

Polaroid Land Film Types

Film Type	Approximate ASA Rating	Picture Size	Remarks
47[3]	3000	3¼ × 4¼	Panchromatic type. Paper print. Roll film only. High-speed film with medium contrast.
107[3]	3000	3¼ × 4¼	Panchromatic type. Film packs only. Paper print. Similar to Type 47.
410[3]	10,000	3¼ × 4¼	Roll only. Panchromatic type. Paper print. Extra high-speed film good for extremely fast waveforms.
46L[4]	800	3¼ × 4¼	Roll form only. Yields positive transparency. Medium contrast. High speed. Panchromatic type.
146L[3]	125	3¼ × 4¼	Slower speed than type 46L. Faster development time. Roll form. Positive transparency. High contrast.
52[3]	200	4 × 5	Sheet form only. Panchromatic type. Yields paper print. Good general purpose film.
55 P/N[5]	50	4 × 5	Positive paper print and reproducible negative. Sheet form. Panchromatic type. High resolution negative.
57[3]	3000	4 × 5	Panchromatic type. Sheet form only. Paper print. Equivalent of Type 47 in sheet form.
48[6]	75	3¼ × 4¼	Color film which yields a paper print. Available in roll form only. Requires no coating.
58[6]	75	4 × 5	Color film which yields a paper print. Available in sheet form only. Requires no coating.
108[6]	75	3¼ × 4¼	Color film which yields a paper print. Available in film packs only. Requires no coating.

[3]Development time 10 seconds.
[4]Development time 2 minutes.
[5]Development time 20 seconds.
[6]Development time 50-60 seconds.

Conventional Film

The matte-finish sprays referred to previously are also good for coating standard prints and negatives on which you wish to mark. Remember that any mark on the negative may appear on the print. This suggests the idea of marking notes on the negative prior to printing.

TABLE 3-3

Conventional Film Types

Manufacturer	Film Name	ASA Speed	Remarks
Eastman Kodak	Tri-X	400	High speed, medium contrast. Roll film.
	R S Pan	650	Similar to Tri-X, in sheet form.
	Royal-X Pan Recording	1250	Ultra-fast roll film with low contrast.
	Royal-X Pan	1250	Same as Royal-X Pan Recording, in sheet form.
	Plus-X Pan	125	Medium speed film with good contrast. Both sheet and roll film.
	Panatomic-X	64	Slow speed, extremely fine grain and resolution. Both sheet and roll film.
Agfa	Isopan	1000	High-speed film with low contrast. Both sheet and roll film.
Ansco	Super Hypan	400	Medium-speed film with medium contrast. Both sheet and roll film.

Fig. 3-2. Using transillumination to see otherwise invisible information.

The paragraphs under Polaroid Land film, on prefogging and postfogging, apply equally well to conventional films.

To increase the contrast of conventional films, the film may be left in the developer longer or the temperature of the developer may be raised; however, this may result in increased grain and fog.

The transillumination technique can be used with conventional-film negative and prints. It is a method by which you may see information that might not ordinarily be seen. Refer to the paragraph on transillumination.

Negative Film Development

Equipment Needed

The bare essentials for the development of negative film are listed below:

1. Developer (If speed or contrast is more important than grain, do not use a fine grain developer.)

2. Hypo (Rapid fixer is most convenient.)

3. Three glass, hard rubber, polythylene, enameled steel, or stainless steel trays or a development tank.

4. Thermometer

5. Graduated measure

6. Two containers of glass, hard rubber, polyethylene, enameled steel, or stainless steel to store the chemicals. The containers should block light from reaching the chemicals. For long-term storage, use brown glass bottles.

7. Timing device (Must be readable or audible in a dark room if one is used.)

Additional equipment which will ease the development of the negative film:

1. Stop-bath (Stops development and prevents contamination of Hypo.)

2. Hypo clearing agent (Allow a shorter wash period.)

3. Photo Flo (Stops water spotting and speeds drying.)

4. Film clips (Plastic clothes pins will do.)

5. Funnel

Procedure

Sheet and Roll Film. (Tank or Tray Development.) Mix the chemicals as directed. Once the chemicals are mixed and at the proper temperature, pour each one into a separate tank or tray. If no stop-bath is available, then substitute water in this tray.

Arrange the tanks or trays with the developer first, stop-bath or water second, and hypo last. Turn out the lights and be sure the room is light-tight. Remove the film sheet from the film holder and attach a film clip to it; or undo the roll of film, remove the film from the paper backing, and attach a film clip to each end of the film roll.

Start the timing device and immerse the film in the developer. Agitate the film at 30-second intervals, being sure that the developer covers the complete image area of the film. If roll film is being developed, see-saw it back and forth through the tank for the development period. Make sure all portions of the roll film receive the same time in the developer.

When the development time is up, switch the film to the stop-bath or water tank. Leave it in the stop-bath for about one minute. Roll film should be see-sawed back and forth through the stop-bath to insure that the stop-bath covers all areas of the film.

Remove the film from the stop-bath at the end of one minute and immerse it in the fixing bath. Roll film should be see-sawed back and forth through the hypo tank in such a way that all parts of the film come into contact with the hypo solution. The length of time in the fixer will depend upon the solution and the type of film. (See the directions packed with the film.)

Place the film into a container in the sink and allow running water to rinse it for about 30 minutes. The water in the container should have one complete change at least every five minutes.

If the hypo clearing agent is used, the washing procedure in the paragraph above becomes:

1. Wash one minute in water.

2. Treat film with hypo clearing agent for 2 minutes.

3. Wash film in water for five minutes.

When the washing is complete, hang the film up to dry using the film clips. Make sure that the film touches nothing while it is drying. The film clips must not be clipped onto an image area.

Storage of Supplies

Conventional Film. Do not open a film package until it is to be used. The vapor tight packaging will protect the film against high humidities. Under high-humidity conditions, film should be exposed and processed as soon as possible. Do not store open packages of film in damp basements, ice boxes, or refrigerators because of the high humidities in these places. If it is desirable to refrigerate an open package of film, it should be placed inside a can or jar which can be tightly sealed to keep out the moisture.

If an open package of film has been stored in a relatively high humidity (above 60%) it should be dried before using, by means of a desiccating agent such as silica gel.

When storing film, the temperature in the area should be about 70° F. If a cool storage place is not available, the film may be stored in a refrigerator. Film may be stored for 2 months at 75° F, 6 months at 60° F, and 12 months at 50° F. The relative humidity of the storage area should be from 40% to 60%. To avoid moisture condensation on cold film surfaces, the unopened package of film should be allowed about 30 minutes to 2 hours to come up to room temperature before opening, after they have been removed form cold storage.

Open packages of film should be kept away from chemical fumes, x-ray, and radioactive materials. Open packages of film should also be in an area with a humidity between 40% and 60%, with 40% preferred. It is better to keep open film in an area of 80° F at 40% humidity than in an area of 65° F at 70% humidity.

The developed film should ideally be stored in an area with a temperature between 60° F and 80° F with a humidity not over 60%.

Developing Solutions. When you are through using the solutions, they should be poured into air-tight containers. The screw tops should be free from rust or other foreign materials and have liners or gaskets. Cork and glass stoppers present sticking problems, and therefore should not be used.

Air is one of the worst enemies of photographic solutions. Oxidation of a solution may take place even in a tightly sealed container if the solution level is low. It is, therefore, advisable to store solutions in a container no larger than necessary.

The storage temperature of the solutions should be about 65° F to 70° F. Temperatures above this may cause rapid oxidation. On the other hand, too low a temperature (below 55° F) can cause the solutions to crystallize. Once a solution has crystallized, it may not be possible to redissolve the crystals. Repeated temperature changes cause photographic solutions to have shorter life.

Most photographic solutions will remain good for about two months if they are stored in air tight containers of the right size and at a temperature of 60° F to 80° F. Each use of the solutions shortens the storage period.

All photographic solutions become weaker as they process additional film. All have a maximum amount of film area that can be run through them, after which they are considered of no further use. (See developer instructions.)

Polaroid Film. The wrappers on Polaroid film will protect it against humidity through the expiration date. Once the film is taken out of its wrapper in high relative humidity areas, it must be exposed as soon as possible.

If it is necessary to store opened rolls or packets of Polaroid Land film, approximately the same conditions apply as with conventional film.

Polaroid film can be used at temperatures from about 40° F to 100° F. However, open film will keep longer in a temperature of 90° F at 50% humidity than it will in a temperature of 70° F at 80% humidity.

Polaroid 4 × 5 film packets are quite sensitive to humidity. The packets can be damaged rapidly when exposed to a humidity above 75%. To protect the packets, insert them into the plastic bag with the film immediately upon removing the foil wrapper. Fold over the end of the bag several times to keep out the moisture.

In high humidity areas the 4 × 5 film packet should be exposed and developed within 15 minutes after it is removed from the bag.

NOTES

SECTION 4

PICTURE TAKING

Photographing Repetitive Signals

The following procedure can be used as a guide to obtain an exposure.

1. Position the external graticule, (if used) for the white lines.

2. Mount the camera bezel on the oscilloscope if the oscilloscope is other than a Tektronix 400-series.

3. Obtain the signal and adjust the controls for the desired display.

4. Attach the camera to the bezel and secure the camera against the oscilloscope.

5. Adjust the Focus, Astigmatism and Intensity controls for a sharp trace.

6. Set the APERTURE selector for the largest lens opening (smallest f-stop number) and carefully focus the camera on the trace or halfway between the trace and graticule in the case where an external graticule is to be used.

NOTE

For a clear reproduction of both the trace and the external graticule, focus the camera halfway between the two.

7. Set the intensity to midrange, scale illumination three-quarters clockwise, SPEED selector to 1/5 second and APERTURE selector to f/5.6. The above control settings should be reasonably close for most film around 3000 ASA rating and waveforms with frequencies near 1 kHz.

Photographing Single-Sweep Displays

Single-sweep displays are formed when the oscilloscope spot sweeps across the screen only once. The actual exposure time is thus determined not by the shutter speed setting, but by the duration of the sweep plus phosphor persistence, provided the shutter is open sufficiently long. In one type of single-sweep photography, the graticule exposes the film for the time set by the shutter while the spot on the screen exposes the film for only the duration of the sweep. It is not usually possible to adjust the trace and graticule for the same intensity and obtain good pictures, since the effective exposure times for the two are different.

Success in obtaining good photographs of single-sweep displays will come only with experience. A few tips, however, may reduce the amount of experimenting required.

1. Use steps 1 through 6, under Photographing Repetitive Signals, to set up the camera.

2. Select a shutter speed setting which is of a longer time duration than the event which is to be photographed.

3. Use the highest practical intensity without causing defocus of the trace.

4. Where practical, use f-stops higher than f/4 if an external graticule is used. This will permit both trace and external graticule to be in focus.

It should be remembered that since the shutter speed has already been determined, the selection of lens opening will determine how well the trace photographs. In single-sweep applications you must make your camera settings for the trace intensity and duration. You cannot use the graticule illumination as a reference.

Picture Troubles

If the trace is too wide (defocused due to high light intensity) on the picture, this may be corrected by either using a higher f-stop number or a faster shutter speed. If the defocused trace cannot be cured by using either a higher f-stop number or a faster shutter speed, the camera needs to be refocused.

No image appears on the picture

1. Inoperative shutter mechanism.

2. Dark slide still in camera back.

Image just barely appears on a picture

1. Use higher intensity and scale illum settings.

2. Use a slower SHUTTER SPEED setting.

3. Set the APERTURE selector for a smaller f-stop number.

4. Use a film with a higher ASA rating.

5. Prefogging or postfogging may help. Refer to the section on Photographic Techniques.

Light streaks on picture

1. Light leaks in bellows. See local Tektronix Representative about repair.

2. Light seal between camera and oscilloscope faulty.

3. Dirty rollers in camera back.

4. Film pack was handled too roughly during loading.

Fogging on picture

1. Oscilloscope Scale Illum control is set too high.

2. Light-struck or bad film.

3. Film was exposed to light during loading.

Either trace or external graticule in focus, with the other out of focus

1. Use f-stop numbers larger than f/4 when photographing an external graticule.

Some portions of photographed signal appear brighter than others

1. Use an exposure which is long enough to allow several sweeps to occur.

Portion of photographed signal cut off by edge of film

1. Make sure film size is sufficient to record the entire signal for the object-to-image ratio lens and the oscilloscope display size being photographed.

2. Adjust rotating slide adapter, if adjustable style rotating slide adapter is being used.

Eliminating Parallax and Focusing Difficulties

Tektronix oscilloscopes with internal "no parallax" graticule and variable edge-lighting will have no parallax problems, and hence no focusing difficulties.

The fact that on some oscilloscopes the trace and graticule are not in the same plane results in some parallax. This also makes it impossible to obtain good focus simultaneously on both the trace and graticule at f-stop numbers below f/4. Both of these difficulties can be eliminated where necessary by either of two methods.

The first method involves double exposing the film. First, set up the oscilloscope display as usual and focus the camera on the trace. Turn down the graticule intensity to minimum and make the first exposure of the trace only. Then turn up the graticule to its former brightness and set the camera lens for its smallest lens opening (largest f-stop number). Readjust the camera shutter speed to compensate for the smaller lens opening. Turn down the oscilloscope trace and make a second exposure of the graticule only. The resulting photograph, due to the greater depth of field when making the graticule exposure, will have no parallax between graticule and trace and will have both the graticule and trace in proper focus. Care must be taken in using this method that the position of the film for the second exposure is the same as for the first exposure.

The second method also involves double exposing the film. Set up the oscilloscope display as usual and focus the camera on the trace. Turn down the graticule intensity to minimum and make the first exposure of the trace only. Then turn up the graticule to its former brightness and refocus the camera on the graticule. Turn down the oscilloscope trace and make a second exposure of the graticule only. The resulting photograph, due to refocusing between exposures, will have no parallax between graticule and trace and will also have both the graticule and trace in proper focus. Care must be taken in using this method that the position of the film for the second exposure is the same as for the first exposure.

Effects of Camera Magnification on Exposure

The camera or lens object-to-image ratio is the ratio of the object size to the image size. For example, a 1:1 lens is one whose object is the same size as the image. The object-to-image ratio of the camera lens has a definite effect on the exposures obtained.

The object-to-image ratio affects the amount of light which will fall on a given point of the film. The smaller the image on the film, the greater the intensity of the light. Therefore, the larger the object-to-image ratio of the lens, the less time required to obtain a good exposure on the film. With a 1:0.5 lens, slightly less exposure time is required to photograph a display than is required with a 1:0.1 lens. The difference in the exposure time required with the various lenses is so slight, however, that they can usually be ignored.

There is less than one camera stop difference between 1:1 and a 1:0.5 lens.

It is important to note that a slightly better writing rate can be obtained with a larger object-to-image ratio than with a smaller object-to-image ratio. Here again, the difference is fairly small unless there is a wide difference in the ratio.

Reciprocity

Decreasing the f-stop number by one unit (e.g., from f/8 to f/5.6) doubles the area through which light can pass and expose film in the camera. Theoretically, such a decrease in the f-stop number requires that the exposure time be halved to produce the same exposure as obtained previously. This results in what is known as the Law of Reciprocity. The Reciprocity Law works quite well for medium intensity light at medium shutter speeds. The law fails, however, for very short exposures from bright light or for very long exposures from dim light. It is only for exposures in the range of approximately 1/250 to 1 second that the Reciprocity Law can be used.

SECTION 5

OPTICAL AND ELECTRICAL DESCRIPTION

LENSES

Aperture Selection

There are basically 4 different lenses which are available for the Camera System. They are the low-cost f/4.5, the general-purpose f/1.9, the high-speed f/1.4 and the extra high speed f/1.3.

Of the four lenses, the low-cost f/4.5 has the smallest maximum aperture. Although not as fast as the other lenses, it is well suited for applications where the oscilloscope trace is moderately bright. These applications include work involving repetitive signals and work at slow sweep rates. The three lens elements used in the lens system produce a high degree of lens correction.

The general-purpose f/1.9 lens has a much greater maximum aperture than the f/4.5 lens, and is used in applications where a very fast lens is required. This includes single-sweep applications at the fast oscilloscope sweep rates. The f/1.9 lens is approximately 5-½ times as fast as the general-purpose f/4.5 lens. The lens system was specifically designed for oscilloscope applications. The high amount of correction designed into the lens system provides faithful reproduction of the oscilloscope display on the film of the camera.

The high-speed f/1.4 lens is intended for applications involving extremely dim oscilloscope traces. The f/1.4 lens is approximately 1-½ times as fast as the f/1.9 lens and 8-¼ times as fast as the f/4.5 lens. This lens includes a high degree of correction to produce images which are faithful reproductions of the original oscilloscope display. It also has been designed specially for oscilloscope applications. The focal length of the f/1.4 lens is slightly different from the other two types, being 88 mm instead of 75 mm.

The extra high-speed f/1.3 lens has been designed for single-sweep photography of very fast sweep rates. The f/1.3 is approximately 5 times as fast as the f/1.4 lens and 12 times as fast as the f/4.5 lens. This lens was specially designed by Tektronix for extremely fast oscilloscope waveforms.

All the lenses provide negligible distortion of the image. Their essential differences are in their ability to photograph extremely dim traces such as those produced in single-sweep applications at the highest sweep rates.

REAR FRAMES AND ROTATING SLIDE ADAPTER

The physical length of the various lenses is quite different. In order to allow for this, and also to compensate for manufacturing tolerances, a special lens-mounting system is used. This mounting system consists of the supports protruding from the front portion of the camera frame and the two locking nuts. The supports and the locking nuts permit lenses of virtually any reasonable length to be installed in the camera.

The various lenses used with the camera system are installed in appropriate lens mounts which give the proper object and image distances, and, thus, the desired object-to-image ratio. The lens mount automatically assures the proper image distance when the lens assembly is installed in the rear frame. The proper object distance is then automatically obtained when the camera is focused.

All of the camera backs used with the camera system provide the same image distance. This means that any two backs can be interchanged without affecting either the magnification of the lens system or the focus of the image.

ACCESSORIES

Shutter Actuator Model 3

Circuit Description

Line voltage is applied to a bridge rectifier made up of D2, D3, D4 and D5. The rectified output voltage is then applied to the shutter actuator solenoid via pins 1 and 3 of J19.

Closing SW9 causes the shutter actuator solenoid to start energizing. As the actuator energizes, its plunger trips SW19, thus connecting pins 1 and 6 of J19 together and causing B15 to light. After SW19 has been tripped, the current path for the actuator is through the parallel combination of R10, R11, R12 and R13 and pin 2 of J19. R10, R11, R12 and R13 reduce the DC output voltage of the power supply to allow the actuator to remain energized indefinitely without damage.

D12 has been installed to suppress the arc which will occur when SW19 switches. Pin 4 of J19 grounds the shutter actuator solenoid and power supply cases to the third wire ground.

NOTES

SECTION 6

CAMERA SYSTEM MAINTENANCE

General Care of the Camera System

The camera system should be given the same care as other precision optical devices. Care should be taken in handling the various mechanisms to assure that they are not damaged. The equipment should be kept covered when not in use to prevent dust accumulating on or in it.

Lenses

In order to obtain maximum use from your camera, care should be taken that the lenses are kept clean and are properly installed in the instrument. When lenses require cleaning, the entire lens assembly can be removed from the camera by first loosening the locking nuts, then separating the rear of the camera from the front, and finally, unscrewing the lens from the rear of the camera frame. When replacing the lens, do not force the parts together. If the parts are mated properly, they will fit together easily.

Loose dust on lenses should be removed with a soft camel hair brush. Fingerprints and other smudges can be removed with clean, high-quality lens tissue. Be careful that you do not scratch the lenses when cleaning them.

Do not attempt to disassemble the lenses. The lens assemblies are sealed; therefore, dirt should not get on the inner surfaces of the lenses. Each lens is individually adjusted at the factory to obtain the correct magnification factor. If the lenses are dissassembled and then reassembled, the magnification factor of the lens will probably be altered.

Special lubricants have been added to the shutter during manufacturing which makes further lubrication unnecessary during its lifetime. It is essential that neither oil nor graphite be used on the shutter, as either may ruin it. If the shutter acts sluggish it may be the result of continuous wear or extreme atmospheric conditions. Dust should present no problems since the shutter is sealed inside the lens system.

Camera Backs

Polaroid film backs used with the camera system should be inspected after each package of film is exposed and before more film is put in the camera. Any reagent on the rollers or other parts of the back should be removed immediately using a moist rag. If reagent is left on the rollers of the back, it may ruin some of the pictures.

Electrical Visual Inspection

You should visually inspect the entire electrical instrument every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged banana jacks, scorched wires or components, or broken terminal strips. For most visible troubles, the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent defects. It is essential that you determine the cause of overheating before replacing heat-damaged parts, in order to prevent further damage.

COMPONENT REPLACEMENT

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from your Tektronix Field Engineer or Field Office. See Parts Ordering Information and Special Notes and Symbols at the front of Section 7.

Soldering to Circuit Boards

The circuit boards have been constructed of the finest materials using the best construction techniques known. Each mounting hole is through-plated to the opposite side of the board, giving it unusual strength and resoldering durability. Components can be removed and replaced on the circuit board numerous times with no fear of lifting the etched circuit from the glass laminate.

1. Use a 35- to 40-watt soldering iron with small wedge-shaped tip.

2. Use needle nose pliers to grip the component lead next to its body before applying heat.

3. Apply heat and lift the lead out of its mounting hole.

When installing a new component, bend the leads to match the length and position of the leads of the removed part. It may help to heat the mounting hole solder to a liquid state and shake out the excess.

Tin the prepared leads of the new part using 60/40 solder, then heat the mounting hole and install the new part.

Do not apply excessive heat. Use sufficient heat, however, along with a small amount of new 60/40 solder, to establish a full-flow clean joint.

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
C	degrees Celsius (degrees centigrade)
F	degrees Fahrenheit
K	degrees Kelvin
dia	diameter
÷	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
e	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
FIL HB	fillister head brass
FIL HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
>	greater than
H or h	henry
h	height or high
hex	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
−	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
±	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xfmr	transformer

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 STANDARD C-40 PARTS

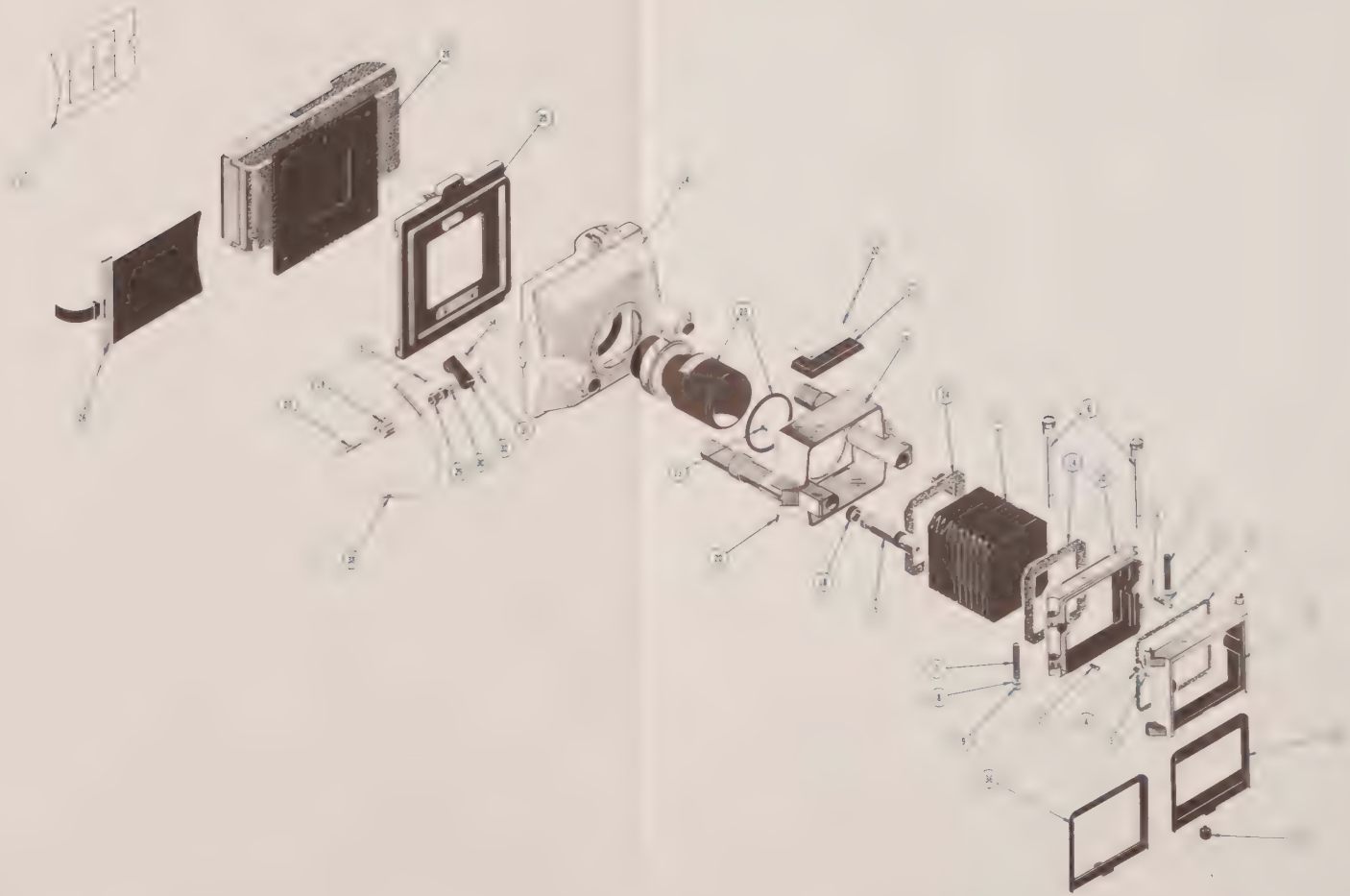
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-	122-0741-01			1	ASSEMBLY, C-40 MAIN FRAME
	- - - - - -			-	assembly includes:
-1	348-0048-00			1	FOOT, rubber
-2	426-0285-01			1	SUPPORT
-3	377-0143-00			2	INSERT, locking
-4	213-0006-00			2	SCREW, set, 8-32 x 3/16 inch
-5	124-0178-00			1	STRIP, light seal
-6	214-0647-00			2	PIN, hinge, w/knob
	- - - - - -			-	each pin includes:
	334-0966-03			1	TAG
-7	214-0626-00			2	SPRING, hinge
-8	210-1009-00			2	WASHER, shim
-9	354-0290-00			2	RING, securing
-10	426-0284-02			1	ADAPTER, support
-11	214-0627-00			1	BELLOWS
	- - - - - -			-	mounting hardware: (not included w/bellows)
-12	211-0123-00			4	SCREW, 1-72 x 3/16 inch, RHS
-13	211-0124-00			4	SCREW, 1-72 x 5/32 inch, RHS
-14	214-0752-00			2	GASKET, light seal
-15	384-0427-00			2	ROD, support
	- - - - - -			-	mounting hardware for each: (not included w/rod)
-16	210-0905-00			1	WASHER, flat, 1/4 ID x 7/16 inch OD
-17	212-0580-00			1	SCREW, 1/4-20 x 3/4 inch, Button Hd. Cap
-18	401-0034-00			4	BEARING, sleeve
-19	122-0740-00			1	SUPPORT, lens
-20	213-0152-00			2	SCREW, set, 8-32 x .375 inch, nylon tip
-21	352-0104-00			1	HOLDER, identification plate
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0087-00			2	SCREW, 2-56 x 3/16 inch, FHS
-22	334-1118-00			1	PLATE, identification
-23	122-0662-00			1	LENS (See Data Sheet)
-24	122-0591-01			1	ASSEMBLY, rear frame (See Data Sheet)
-25	122-0602-00			1	ASSEMBLY, rotating slide adapter (See Data Sheet)
-26	122-0603-00			1	ASSEMBLY, Polaroid roll-film back (See Data Sheet)
	122-0587-00			1	ASSEMBLY, release cable adapter
	- - - - - -			-	assembly includes:
-27	211-0517-00			1	SCREW, 6-32 x 1 inch, PHS
-28	366-0176-00			1	KNOB
-29	210-0844-00			2	WASHER, rubber
-30	358-0179-00			1	BUSHING
-31	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-32	204-0118-00			1	BODY
-33	213-0108-00			1	SCREW, 1/4-20 x 3/8 inch, RHS
-34	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD

STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-35	354-0280-00*			1		RING, light seal, 453 (installed)
-36	354-0279-00*			1		RING, light seal, 422
-37	387-0460-00			1		PLATE, focus
-38	122-0586-01			1		CABLE, release
	070-0616-00*			2		MANUAL, instruction

*Also supplied with main frame purchase separately.

FIG. 1 STANDARD C-40 PARTS



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TEXT CORRECTION

Change all references to rotating slide adapter Tektronix Part Number 122-0602-00 to rotating slide adapter Tektronix Part Number 122-0739-00.

5-inch Cameras and Accessories manual

ADD: the following information to page 2-5 and after the paragraphs titled Later Style Rotating Slide Adapter.

C-40 Camera and Accessories manual

ADD: the title Non-Adjustable Style Rotating Slide Adapter after the first paragraph under the title Mounting the Camera Backs on page 2-3.

ADD: the following information to page 2-3 after all present data under Rotating Slide Adapter.

Adjustable Style Rotating Slide Adapter

When the rotating slide adapter is in place, press down on the slide index lever. While holding down the slide index lever, insert the desired camera back onto the tracks of the rotating slide adapter. Be sure to hold onto the camera back until the slide index lever has been released and the camera back has been firmly locked in place.

The camera back may be positioned in any one of nine positions by pressing the slide index lever and moving the camera back to the desired positions. The various stops of the camera back have been numbered--this number will appear in a small hole of the slide adapter assembly.

It is a good idea to leave the dark slide in the camera back until the back has been properly seated on the camera. The dark slide should also be used whenever the camera back is changed if either back contains film.

The adjustable rotating slide adapter has been constructed so that it can correct for discrepancies in vertical and horizontal film tracking in the camera back, and/or slight camera system misalignment. If the image is always off center on the film frame in the same direction, one, or both of the above difficulties is probably the cause.

The following procedure should be used as a guide when making film framing corrections with the rotating slide adapter.

a. Note the amount and direction of image movement which will be required to center the image on the film frame.

NOTE

The amount of correction required to center the image on the film frame is one-half the distance from the present image position to the new image position.

The direction the rotating slide adapter must be moved with respect to the rear frame to center the image is the same direction the image must be moved on the print, as normally viewed, to become centered.

b. Remove the camera back from the rotating slide adapter. It is not necessary to remove the rotating slide adapter from the remainder of the camera system.

c. Note the relationship of both the vertical and horizontal white index lines to the index marks of the rotating slide adapter, see Fig. 1.

d. Loosen, but do not remove the four countersunk screws, see Fig. 1. Move the back portion of the rotating slide adapter to the desired position, using the vertical and horizontal white index lines and the index marks of the rotating slide adapter as alignment guides.

e. When the rotating slide adapter has been correctly positioned, re-tighten the four countersunk screws, see Fig. 1.

NOTE

Seldom will the adjustment of the rotating slide adapter remain ideal when the camera is switched from oscilloscope to oscilloscope or after various camera components are interchanged.

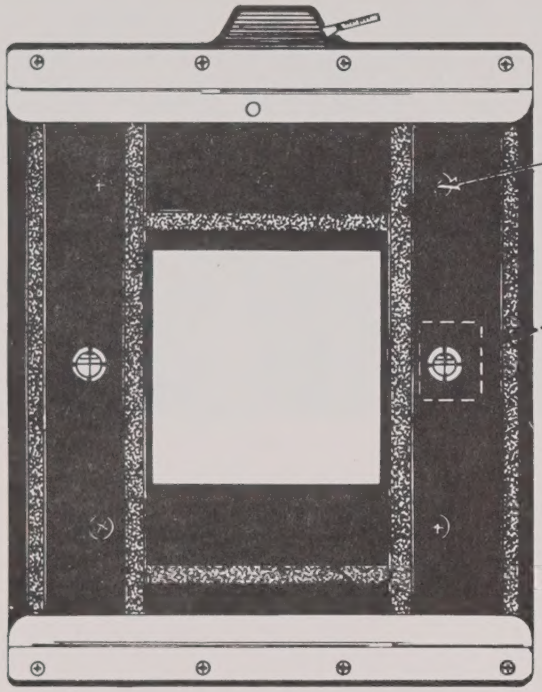

Countersunk screws
White index lines
Index marks
NOTE
Maximum rotating slide adapter movement from its nominal mechanical center as shown in this figure is up 0.150 inch, down 0.030 inch, right 0.090 inch and left 0.090 inch.

Fig. 1. Adjustable Style Rotating Slide Adapter.

ADD: the following to page 4-2 in the 5-inch and C-40 Camera and Accessories manuals, after the information following the title. Some portions of the photographed signal appear brighter than others.

Portion of photographed signal cut off by edge of film.

1. Make sure film size is sufficient to record the entire signal for the object-to-image ratio lens and the oscilloscope display size being photographed.

2. Adjust rotating slide adapter, if adjustable style rotating slide adapter is being used.